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Preface

We start to publish our Bulletin of "Teaching of Astronomy in Asian-Pacific Region" of the International Astronomical Union (IAU) by this issue of February 1990. A Working Committee (WC) of astronomical education in the Asian-Pacific (AP) region of the IAU was settled during the A-P regional meeting of the IAU held in Beijing in October 1987, to discuss our efforts for activation of astronomical education in the AP region. After exchanging some numbers of letters within members of the WC, the chairman of the WC made proporsals on our activities: 1) to promote exchange of materials and techniques for astronomical education, 2) to promote activation in teaching of astronomy at some AP countries having no professional astronomers, 3) to promote exchange of school teachers and their ideas, and 4) to start a regular (semi-annual at the begining) publication of this Bulletin. These proporsals were approved at the WC meeting in Baltimore, USA during the IAU General Assembly in August 1988. The Chairman of the WC hopes this Bulletin will support activities of astronomical education in the AP countries and will develop much.

February 26, 1990

Syuzo Isobe
Chairman of the WC

Members of the WC
S. Isobe (Chairman; Japan), A. A. Aiad (Egypt),
B. Hidayat (Indonesia), Z. Lee (China),
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COMMUNICATING SPACE TO THE PUBLIC IN AUSTRALIA

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ABSTRACT

Improved public understanding of space engineering and science issues is crucial to gaining wide support for the continuation of space programs. Accordingly, it is necessary to convey clear information on the value of space activities to all parts of the community, emphasising their influence on everyday life. This large task involves marketing by the space community to the media, educators, community organisations and commercial bodies. Appropriate media strategies, curriculum planning, special events, electronic information services and museum roles are suggested for implementation.

WHY COMMUNICATE TO THE PUBLIC?

This paper is an effort to highlight the importance of educating the general community about space and some of the means to that end. It is hoped that as a result of discussion on the topic, planning can advance for the second "Communicating Space to the Public" space education conference to be held in Melbourne in May 1991 under the auspices of the Australian Astronomy and Space Education Liaison Group and the Australian Space Policy Institute.

Although the public see science and technology (scitech) as one of the most important influences on their way of life, their attitudes are marked by ambivalence, wariness, and a sense of the inevitability of technological progress. There is growing concern that the gulf between scitech developments and public understanding is widening, with possibly serious implications for the future of Western industrialised and democratic societies. Similar considerations apply to space science and technology which already include aspects of physics, botany, medicine, electrical engineering, fluid mechanics, chemistry, law, economics and so on. Public and Government support for space can be viewed as one part of the recognition of the role of technology in our future.

At present though, the public's attitude to space is a mixture of awe, anti-technology feelings, pseudo-scientific ideas and an ignorance of the role that we can play in space. As space exploration programs grew out of intercontinental ballistic missile programs, they are often seen by people as military programs, with all the negative socio-political and cultural connotations that our society currently places on such activities. Yet this view hides the potential for private space ventures, beneficial space applications and personal involvement in space program management. Every one of us is affected by communications satellite services, weather satellite predictions, and navigation satellite use by airlines, just to cite a few examples. This personal level of the influence of space technology needs to be stressed to the person in the street, and our efforts at communicating space to the community should be directed at a personal level as appropriate.

STRATEGIES FOR COMMUNICATION

The importance of space activities must be conveyed to all sections of the community. This includes the political and commercial sectors, the media, educators and the general public. Creating a "space aware" society is the first and most important step in generating public, and ultimately political and business support, for space policies and aerospace industry activities.

Clear, straightforward explanations in non-complex, non-jargonistic language, supported by visuals wherever possible, are the best method of getting the message across. It is important to bear the target audience in mind at all times during the development and presentation of any materials. Poorly prepared attempts will not only fail to reach their target, but may also serve to damage the space awareness cause by alienating the audience and hence reinforcing negative stereotypes of science and technology.

Care should be taken to select the most appropriate medium for the information to be conveyed, so as to obtain maximum exposure for the message and benefit for the public relations effort involved. The electronic media prefer short, lively, non-technical presentations of information, with good visual images for television. The print media offer better opportunities for the exposition of more complex subjects, or issues which require more comprehensive, detailed or technical information. Ideally, it is preferable to aim for multi-channel dissemination of information, with specifically tailored packages for each of the different media targeted. In this way, the widest possible community exposure can be achieved and the message itself is re-inforced by delivery through different channels.

THE MEDIA FOR THE MESSAGE

Because of their pervasiveness in our society, the electronic media are the most important tool in engendering community space awareness and every opportunity to use them must be effectively utilised. News bulletins, news magazines and current affairs programs cover the widest possible demographic audience of all electronic media productions and are, therefore, a prime channel for communicating space to the broadest cross-section of the community. The current space-related content of these programs is very low and rather narrowly focussed. But the frequency of occurrence of space-related news items compares favourably with the general coverage of science and technology. This indicates that news program producers at least recognise some interest in space on the part of their audience, and are consequently prepared to accord some air-time to space-related stories.

After the news and current affairs programs come a wide range of television and radio programs which provide access to narrower, more specialised audiences who can be targeted with specific messages. Foremost among these are the popular science magazine programs which provide ready access channels for communicating space to audiences at least generally receptive and pro-science. Business and financial programs similarly provide opportunities for the proponents of space industry and commercialisation to present their case. Health and lifestyle programs offer a forum for publicising the many medical spin-offs that have been derived from space research. The range of children's current affairs, science and educational programs can be very useful for conveying information about space activities to a particularly receptive audience. Similarly, the multi-cultural and ethnic media should not be ignored as channels for raising space awareness, especially when it comes to highlighting the international nature of much of today's space activities. Documentaries, chat-shows, variety and talk-back programs on radio and television reach large audiences, including the overlooked, such as the homebound and elderly.

Newspapers and news magazines not only provide all the communication opportunities of their electronic counterparts, they also offer the possibilities of feature articles, which can be used to focus on specific space issues or aspects of space technology. Regular scitech columns in the daily newspapers offer avenues for reporting the most recent developments. Cultivating good relations with science journalists is just as important as with the electronic media, since it may lead to opportunities to suggest space related topics for regular columns and feature articles. Specialist newspapers and magazines should be considered major channels for reaching specific markets, and initiatives should be taken to encourage staff-journalists to produce space-related articles. Science and business magazines are the prime targets here, but others catering to almost every imaginable pastime should not be overlooked for their link to a space theme. Similarly, the ethnic press should not be overlooked, nor the burgeoning field of children's and teenage magazines.

ALTERNATIVE PROGRAMS

In today's increasingly computer literate and using society, computer-based information services, data-bases and billboards provide exciting new avenues for communicating space awareness. In the United States, NASA's highly successful 'Spacelink' public access database is only one of a growing number of both free and subscription space information services accessible.

Around the world there is a growing movement to introduce space studies across the entire school curriculum using the students' general interest in space as a lead-in to a broad range of subjects such as geography, history, social studies and Earth science, as well as the more obvious mathematics, physics and chemistry. The aim is to increase the students' general awareness and knowledge of the role of space science and technology in their lives, and also encourage them to undertake more high level studies in mathematics and science, eventually leading to associated scitech careers. Public pro-space societies have a special role to play in communicating space to the public, harnessing the enthusiasm of their already space-aware members. Often these societies create their own opportunities through displays, public lectures, and special events.

Museum and science centre displays can be important venues for educating the public about space, reaching an average thirty percent of the community. They offer unique opportunities for genuine examples of space hardware to be displayed to the public. Space related facilities often maintain small visitor's centre displays. Science centres and Omnimax facilities also offer special opportunities to cover space science. Commercial or government temporary space displays at shopping and exhibition centres allow the advantages of exhibitions to be taken to the public.

Exposure of space matters has particularly expanded over the last five years, but more needs to be done. The pressure must be maintained by all of us concerned about the world's technological future.

AUTHORS' NOTE: A version of this paper was originally presented at the Fifth National Space Engineering Symposium at Canberra, Australia in November 1989. A copy of the full paper will be found in the text of the Proceedings. This summary is presented here because the authors believe that the issues raised, and strategies suggested herein are as relevant to the astronomical community as they are to other areas of space science and technology.

A BRIEF REPORT ON TEACHING OF ASTRONOMY AT CHULALONGKORN UNIVERSITY

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SUMMARY

This is to introduce the Astronomy Group at Chulalongkorn University, its members and activities. The group serves the nation by educating its youth and the public in general beside doing basic research in astronomy and space science.

INTRODUCTION

Chulalongkorn University, established in 1917, is the nation's oldest university and the first university to provide training in astronomy in its Department of Physics, which was founded in 1934 as the first of its kind in Thailand.

Astronomy teaching and research have been carried out since the very early history of the Department of Physics. The number of staff members trained in astronomy has grown slowly from one, about forty years ago, to the present number of ten, consisting of six faculty members and four supporting technicians. Former students, both graduates and undergraduates, who have studied astromony at the Department are now working in the country's only planetarium and in universities and colleges around the Kingdom.

THE PRESENT STATE OF ASTRONOMY ACTIVITIES AT CHULALONGKORN

We have a long history of astronomy activities on campus with our resources mainly devoted to training undergraduates and M.Sc. candidates. Currently, the Department offers undergraduate courses in Introductory Astronomy, Spherical Astronomy, Celestial Mechanics, Galactic Astronomy, Basic Astronomical Instruments, Theoretical Astrophysics and related courses in Relativity, Meteorology, Optics and Electronics. Courses offered at the graduate level are Solar Physics, Astronomical Instruments, Astronomical Techniques, Theory of Stellar Atmospheres, Celestial Mechanics and Selected Topics in Astrophysics.

We have instruments for the training of students and for conducting research such as a telescope, a heliostat, a spectrograph, lenses, mirrors, gratings, prisms, cameras, filters and film, which can be set up for special observation programs wherever and whenever the occasion arises. The biggest mirror is a twelve inch and the best grating is a high quality reflection type. Most research has concentrated on the sun, eclipses, comets, theoretical modeling and computational astronomy.

Besides educating students and doing research, we also have obligaion to the public. Our members occasionally lecture off campus to various groups, write articles in popular magazines and conduct radio programs in astronomy. Moreover, tours to view comets and eclipses are arranged according to public interest.

THE STAFF MEMBERS

Of the six faculty members trained in astromony, Dr.Rawi Bhavilai, a professor emeritus of the Physics Department, has done work in solar physics. Dr.Pornchai Pacharin-Tanakun, the leader of the astronomy group, has experience in numerical modeling of accretion disks and stellar winds. Mr.Sompong Jaidee has done research in stellar astronomy. Mr.Manit Rugivarodom has experience in spectroscopic study of solar atmosphere. Dr.Pirapat Sirisomboonlarp has worked on positional astronomy. And, lastly, Mr.Sathon Wijarnwannalak holds a master degree in spectrograph design.

Four technicians provide valuable service to the group. One of them is a darkroom expert, one is a telescope assistant or night assistant, the other two are machinists. Under the direction of Dr.Rawi Bhavilai and Dr.Pornchai Pacharin-Tanakun, the technicians produced and ran equipment for the photographic study of Comet Halley during the 1985-1986 apparition.

Seven faculty members in other related fields: two cosmic ray physicists, two optical scientists, two electronic physicists and one meteorologist, are very helpful in providing relevant contributions. They operate the optical and electronic shops and their command of their respective fields enhances our group's experience and widens our perception of the astronomical world.

A NEW RESEARCH-CLASS TELESCOPE

The Japanese Government has granted us a 45 cm cassegrain reflector together with a computer control system, a photoelectric photometer and a spectrograph. It will be the largest telescope in Thailand. The system should be ready to see first light early in 1991.

The telescope with its instruments will be worked to its full capabilities in providing research and education opportunity to anyone who has an interest in astronomy.

INTERNATIONAL EXCHANGE

Members of the astronomy group have taken part in several international meetings. For example, Dr.Rawi Bhavilai has been to several IAU (International Astronomical Union) General Assemblies and meetings. Dr.Pornchai Pacharin-Tanakun attended the International School for Young Astronomers in Indonesia in 1983 and participated in the 1985 XIX IAU General Assembly in New Delhi, where he was proposed as an advisor to IAU Commission 46: Teaching of Astronomy; and finally became a full member of the Union at the XX Assembly in Baltimore, 1988. Mr.Manit has also been to the International School in Malaysia in 1990. It is hoped that when we are ready, the University will apply to the IAU for the Visiting Lecturers' Program and will seek cooperation with other astronomical observatories abroad, particularly in Asia. Our role in trainig future young regional astronomers through IAU's International School shall also be considered.

TEACHING OF ASTRONOMY IN JAPAN:
— Some problems in the New Course of Study —

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ABSTRACT

By 1989 new course of study in elementary and secondary school had been devised and been started. I will report about astronomical contents in the new course of study. That new course of study has some problems related with recent research of science education in which to know that how children's concepts and misconceptions are constructed is important and in which philosophy of science plays also an important role.

I. Introduction

For science education of elementary and secondary school, there are some innovative views. One is the view that children's cognition on science learning is important. We must know how children's concept is constructed. However, we have little idea of how and what children's concept about astronomical events and objects are constructed. They sometimes construct misconceptions which we can't accept, which have to be repaired or exchanged for reasons that they are different from the accepted views which are believed that it is true by scientists. In this respect, researchers of science education study what and how children have concepts using results of cognitive psychology.

Another is the view that philosophy of science contribute to how to learn scientific methods. In philosophy of science, a scientific method which we discuss as "view of new philosophy of science " that has appeared since Kurn (1962) suggest in " The Structure of Scientific Revolutions" is not different from the previous one, which we call as "traditional philosophical perspective". Science education has been affected by "view of new philosophy of science " for recent 10 years. It is typical that a campaign of STS (Science/Technology/Society) curriculum have already carried out in U.S.A. and U.K. This campaign has a purpose to deal with social problems through understanding appropriately about interaction among science, technology, and society. It is important that core view in STS curriculum is "to learn about science" rather than "to learn science" which has been teaching in science education.

By 1989 the new course of study in elementary and secondary school had been devised and started. In this work I will report the contents of the new course of

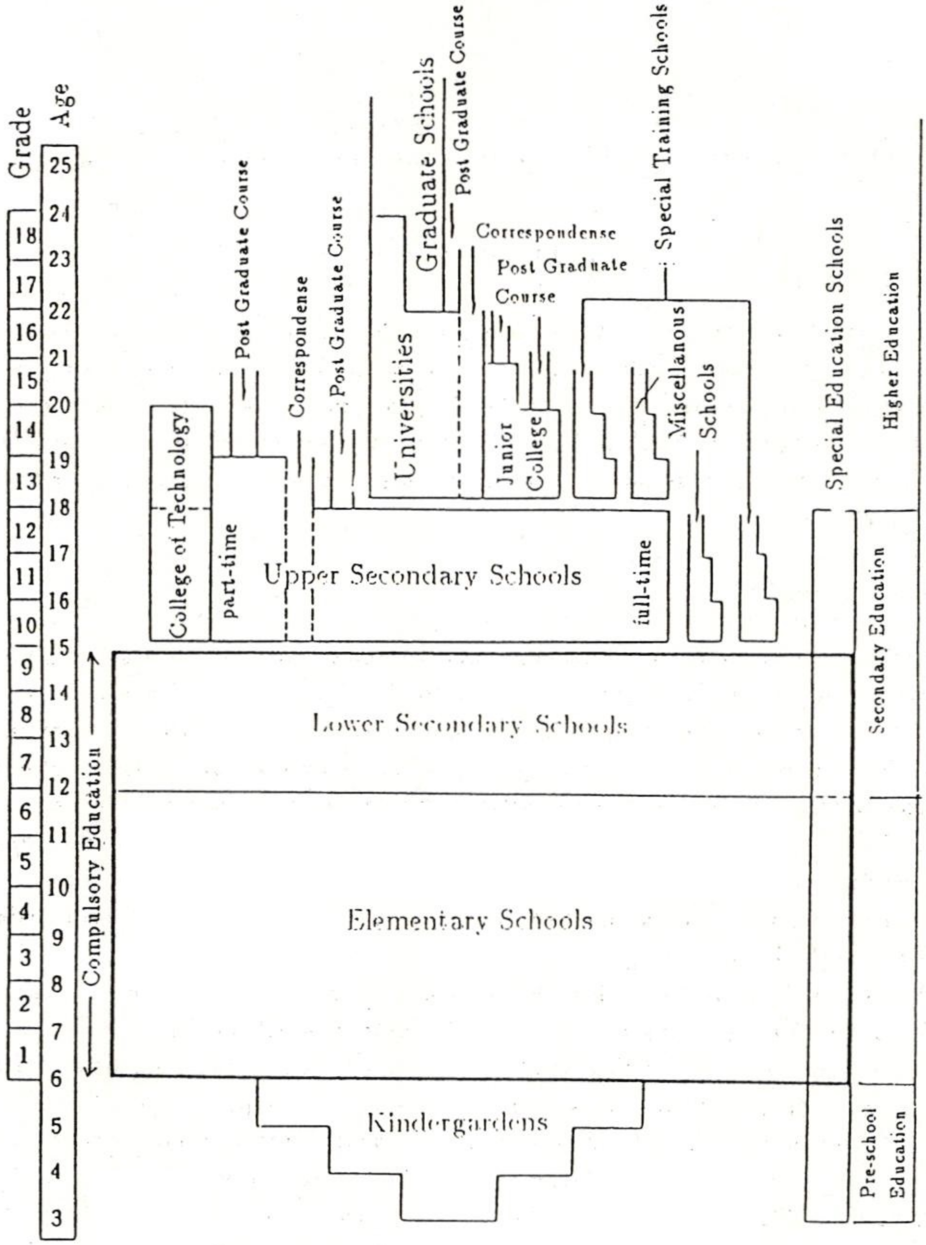

Figure 1. Organization of Present School System in Japan

study in Japan and point out some problems about teaching of astronomy in Japan from results of resent science education.

II. Science Education in the New Course of Study

Figure 1 is the organization of present school system in Japan. The new course of study had revised after an interval of about ten years, which is constructed by the Japanese Ministry of Education. There are some changes in contents and subject names.

a) Elementary School

In this revise, largest modification in elementary school is to have built a subject "seikatu-ka", Life Study, as new subjects in stead of abolition of Science and Social Study in grades 1 and 2. Scientific contents in elementary school is not almost changed because a part of Life Study also include scientific contents.

Elementary is from grade 1 to 6 and scientific contents as Science are learned in grade 3-6. Science is divided three divisions which are not distinct subject as teaching science; division A: "Life and its Environment", division B:"Materials and Energy", and division C:"Earth and Space". Astronomical contents are a part of division C.

b) Lower Secondary

Lower secondary is from grade 7 to 9. There are two fields in "Science" which is also undivided as subject: Field 1 is contained of physics and chemistry, and field 2 is contained of biology and earth science. Astronomy is in Field 2 and is mainly learned in grade 7 in unit of "Earth and Solar System".

c) Upper Secondary

Upper secondary is from grade 10 to 12. There are 5 division and 13 subject, which is shown in Table 1 as comparison to previous subjects. Student must select more than 2 divisions from 5 divisions and 9 subjects from General Science, Physics IA and IB, Chemistry IA and IB, Biology IA and IB, and Earth Science IA and IB. Student learned each IB subject is able to learn each II subject which is farther than subject IB. Subject IA make mach of daily lives. In each subject, computers must be used for problem solving and others.

Astronomical contents in Earth Science IA, Earth Science IB, and Earth Science II. Other contests are geology, geophysics and meteology.

As a part of General Science astronomical contents are taught.

III. Astronomy in New Course of Study

Table 1. Subjects of Upper Secondary

Previous(1978)		New(1989)	
Subjects	Credits[a]	Subjects	Credits[a]
General Science I[b]	(4)	General Science	(4)
General Science II	(2)	Physics IA	(2)
Physics	(4)	Physics IB	(4)
Chemistry	(4)	Physics II	(2)
Biology	(4)	Chemistry IA	(2)
Earth Science	(4)	Chemistry IB	(4)
		Chemistry II	(2)
		Biology IA	(2)
		Biology IB	(4)
		Biology II	(2)
		Earth Science IA	(2)
		Earth Science IB	(4)
		Earth Science II	(2)

[a] 1 credit = 35 classroom hours of lesson. One classroom hour = 50 min.
[b] Required Course.

Table 2 and Table 3 show comparisons of previous and new contents concerned with astronomy in "Science" of elementary schools and lower secondary schools, respectively. Contents of the new course of study is shown as follows.

a) Elementary School

- Grade 3

Sunny Side and Shadow
In this grade pupils learn about relation between sunny side and shadow caused with direction of sun. As metological contents they also learn about relation warmth and wetness.

- Grade 4

There is no astronomical contents.

- Grade 5

Sun and Moon
In this grade pupils observe and learn positions, movement and shapes of sun

Table 2. Astronomical Contents in Elementary Schools

Grade	Previous(1978)	New(1989)
Grade 1	shadow	————————
Grade 2	shadow caused with sun	————————
Grade 3	********	sunny side, shadow and position of sun
Grade 4	shape and movements of sun and moon	********
Grade 5	movements of stars and constellations	shape and movements of sun and moon
Grade 6	seasons and altitude of sun	movements of stars

and moon.

- Grade 6

Star and its Movement

In this grade pupils observe brightness, color and position of stars and they learn characteristics and law that star move regularly.

b) Lower Secondary School

Astronomy is learned in grade 7 in unit of "earth and solar system". There are several items.

i) Familiar Astronomical Object

- Moon and sun
- Apparent motion of celestical objects by earth spin
- Apparent motion of celestical objects by earth rotation

The student find characteristics of moon, sun and earth from observations and references.

ii) Planets and Solar System

- Difference between planets and stars:

Table 3. Astronomical Contents in Lower Secondary Schools

Previous(1978)	New(1989)
i) Movements of Earth	*i) Familiar Astronomical Object*
• Apparent motion of celestical objects and earth spin	• Moon and sun
• Apparent motion of celestical objects and earth rotation	• Apparent motion of celestical objects by earth spin
	• Apparent motion of celestical objects by earth rotation
ii) Componts of Solar System	*ii) Planets and Solar System*
• Shapes and charactor of earth, moon and sun	• Difference between planets and stars:
• Solar system	• Movement of planets and solar system:
iii) Stars and Cosmic	
• Relation among color, brigtness, temperature of stars and distance from earth	
• Our galaxy consist of a number of stars	

- Movement of planets and solar system:

c) Upper Secondary School

In Upper Secondary it is different from elementary and lower secondary in the point of selection of subject. In previous course of study, "Earth science" is only selected by about 7 % of all (Tubota 1990). Though this value may be owing that one student probably selected more than two subjects, selection of earth science in the entrance examinations for national university is nearly equal, which is about 6 %. These value are so lower than other Physics (22 %), Chemistry (39 %), and Biology (32 %) (Tubota 1990). These tendencies will not be changed in new course of study. Many suppose that selection of Earth Science is worse. Other reason of low rate of selection is a small number of teachers teaching "Earth Science", moreover there are a little with abilities of teaching astronomy.

Astronomical contents in upper secondary are shown as follows.

i) Earth Science IA

This subject is taught for growth of scientific views and thoughts through observing familiar events around us.

Theme is "Movement of astronomical objects and human life"

- Time: Movement of Sun and Stars in Celestial
- Season and Emhemeris Time: Relative Position and Periods of Earth, Moon and Sun

ii) Earth Science IB

This subject have purpose that the students acquire ability of research through observations and experiments and understand fundamental conception, principles, and law.

Theme is "Earth in Space"

- Earth as Planet: Spin and Rotation of Earth, Movement of Planets
- Sun and Stars: Sun, Stars, Stellar Evolution through HR Diagram, Energy Source of Star
- Research Activity about Earth as Planet

iii) Earth Science II

This subject have purpose that the students have ability of research through observation and experiments and understand fundamental conception, principles, and low.

Theme is "Cosmic Components".

- Our Galaxy: Distributions of Stars and Gas in Galaxy, Structure of Galaxy
- Galaxies: Shapes and kinds of Galaxies, Distance and Distribution

iv) General Science

Astronomical materials are used as a part of "understanding of nature". There are a little students who will select this subject as well as General Science II of previous course of study.

IV. Some Problems in New Course of Study

Many teachers who teach science including astronomy in elementary and secondary school point out as follows.

- There are small numbers of teachers with abilities of teaching astronomy.
- There are a little contents about astronomy.
- It is difficult for pupils and students to understand astronomy.
- There is a gap between interest of student and contents of curriculum.
- The students must study for the entrance examination of advanced school.
- Observations are not sufficiently achieved much and at all owing to various problems.

- The students are not growing up with time-space conception.

Mentioned above the problems are summarized into three problems in teaching of astronomy. Firstly it is concerned with training teachers with abilities of teaching astronomy. It is also concerned with problems of university of training teachers. Those problems are argued at many domestic and international conferences and papers (*e.g.* Owaki and Isobe ; IAU Colloquium No.105).

Secondly it is concerned with children's cognition of time-space . We must know the actual condition of children about how they think in astronomical materials. However, we know little about how formation of children's concept, especially time-space conception, is going on. In new course of study, though curriculum and materials is considered about the actual condition of children, those are little mentioned about the cognitive process of children and why and how children make misconceptions. Research into children's concepts of astronomical object, *e.g.* earth, moon and sun, reported that children construct their own ideas and meanings for the events they observe in the natural world long before they receive any formal education.Nussbaum and Novak (1976), Nussbaum (1979), Sneider and Pulos (1983) and Baxter (1989) revealed and confirm this view. These concepts of children are seen in cross-cultual study (Mali and Howe 1979; Klein 1982; Matumori 1986). These studies reveal that children construct similar conception for astronomical events though difference of cultural and social environments and educational system cause different understanding.

Although these researches show a reduction in the more naive views as age increases, misconceptions persist in many children and some pass on into adulthood. It is the fact that many children's notions have historical ideas which ancient people thought, which is, strictly speaking, different between children's concept and the ancient concept in the view point of philosophy of science. Children change concept about astronomical events as age increases.

Thirdly it come from philosophy of science. We don't mention about the scientific method and science education curriculum because those are being discussed by a number of studies of science education (*e.g.* Hodson 1985; Hills 1989). On atronomy education, Owaki (1987) claim the meaning. In the new course of study, however, astronomical contents which include significance of philosophy of science don't seem to be discussed sufficiently.

V. Conclusions

Many researchers have reported various problems of teaching astronomy in materials and curriculums, most of which are based on the views how efficiently teachers teach astronomy to children by using good materials. What are then "good" materials ? Most of "good" materials as we called are devised practically. Recent science education research reveal the importance of children's cognition. In this respect, we have to develop "good" materials.

In Japan the new course of study had revised after an interval of about ten years. It is seemed that there are some problems in the new course of study from point of view that studies of science education have been tending to change next phase. Recent science education studies reveal the importance of children's cognition which is researched on method of science, curriculum, and materials through philosophy of science and cognitive phycology. It is a time that we may again have to recognize a role of astronomy in schools among science education.

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INTERFERENCE BY LIGHT OF ASTRONOMICAL OBSERVATIONS

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1. Introduction

Modern society is a very complicated system; one of the complexities is the fact that the production and the consumption usually are located at different places, far from each other. Production and consumption are in this respect not restricted to material items: information and means for cultural or physical recreation and enjoyment are part of them. All this requires a very large amount of transportation; a large proportion of this it is road transportation of persons or goods.

The perfection of artificial lighting permitted to have such transportation at night in the absence of (natural) daylight: life can go on also after sun-set! From this point of view, artificial lighting is one of the major assets of our - technological - culture.

Because a large part of the transportation of persons and goods takes place on the open road, there is a great need for outdoor lighting. This outdoor lighting, however, has serious draw-backs: it causes disturbance and discomfort for many persons, many of whom has nothing to do with the transportation for which the lighting is installed. Here we are facing "light trespass". Light trespass has victims; one group of victims are the astronomers - both the professionals and the amateurs. They are restricted in their possibilities to make accurate observations.

Some people have a simple solution for light trespass: just switch off all outdoor lighting. Fortunately, also the victims of light trespass are more reasonable in their approach. The solution of the light trespass problems has to be found in improvements of the lighting design, where the function of the lighting is compared to the adverse effects of it. It will be necessary to improve the co-operation between the astronomical and the lighting communities.

2. Light trespass

Light trespass is a matter of major concern for the astronomers. Usually, it presents itself in the form of a sky glow in the vicinity of large urban or industrial concentrations. The luminance of the sky glow can conveniently be expressed by "Walker's law" that can be written as:

$$\text{Log } p = -4.7 \log R - \log \varnothing$$

(after Anon, 1984; see Walker 1973) in which p is the ratio between the observed sky glow as measured in the direction of the source under an elevation of 45 degrees and the natural background radiation, R the distance to the source (in km) and ø the total luminous flux of the outdoor lighting in the source (in lumen). The background radiation is usually taken as amounting to 2.10^{-4} cd/m^2. This law is established for cities in the South-West of the USA (Crawford, 1983, 1985; Turnrose, 1974; Walker, 1973). It seems to be applicable for other locations as well (Fisher & Turner, 1977).

More recently, the publications of Garstang gave a more solid mathematical basis for the assessment of the night-sky brightness. First, a flat-earth computer model was constructed (Garstang, 1986). The calculated values agreed well with the observed data, but the inclusion of distant urban agglomerations required a further adaption of the model that allowed for the curvature of the earth (Garstang 1989). The model is based on the physical properties of atmospheric scatter. The adapted model is applied to a large number of sites with considerable success. Further data are needed to extend the model for wider use; notably the approximation of the use of artificial light by taking 1000 lumen per head seems not to be valid for all countries. Finch et al. (1980) suggested values between 500 and 1000 lumen per head, but Schreuder (1988) concluded that values as low as 50 lumen per head can be found as well.

A special colloquium sponsored jointly by IAU and CIE was organised on this subject in conjunction with the IAU General Assembly (the IAU Colloquium No. 112 "Light pollution, radio interference, and space debris", August 13 - 16, 1988, Washington, D.C.; see Anon 1988).

Surveys of the problems of sky glow and of the remedies against it are given in Anon (1985, 1985a) and IAU/CIE (1980) and also in the special issue of Vistas In Astronomy (Anon, 1985b).

The sky glow is a result of all outdoor lighting installations. In the urban areas as are prevalent in the South-West of the USA the contribution of road lighting seems to be only small as compared to the contribution of other outdoor lighting, particularly of billboard and advertisement lighting. According to Finch et al. (1979) for the city of San Carlos (Cal.) the street lighting contributes only 14% to the total (direct and reflected) upward luminous flux, 86% comes from other sources. A large part of the upward flux comes from billboard lighting by means of floodlights; a practice that is not widely in use outside the US.

Waldram (1972) concluded on the basis of calculations of light scatter in the atmosphere that in a particular English town the contribution of the downward flux to the sky haze luminance, even of non-cut off lanterns, was about three times the contribution of the upward flux. More in general it is, however, not known what is the situation in other parts of the world where rather different practices of outdoor lighting may be found. Particularly it would be of interest to know how far Walker's law applies for continental Europe, and what would be the portion of street lighting in the upward luminous flux, because recently street lighting is mostly by semi-cut-off lanterns.

It should be kept in mind that a great part of astronomical observations are made in the infrared and ultraviolet regions. Furthermore, a large part of the observations involve spectroscopy. This implies that it is not enough to consider the "white" visible light of the sky glow; its spectral composition is also important. Finally, other natural or man-made disturbances may hamper astronomical observation (radio emission, vibration, air pollution etc.; see Anon, 1984, 1985, 1988).

3. The function of road lighting

The primary function of transport lighting is to permit that societal activities may proceed also during the time that the (natural) daylight is lacking. The two major categories of transport lighting are the lights carried by the traffic participants (the vehicles) themselves and the public (overhead, street) lighting. We will deal mostly with the latter because very little is known about the contribution of the former to the light trespass; furthermore, there seem to be no remedial measures that are practically applicable at present or in the near future.

The function of road lighting is derived from the visual task aspects of the traffic participants. Here we will concentrate on (car) drivers as their task is the most demanding. The task of drivers is two-fold:
- to reach the destination of the trip;
- to avoid collisions while doing so.
Broadly speaking, the first task involves the selection of the route and maintaining it, the second task is related to the avoidance of incidents and obstacles. Details of this "model" for traffic participation are given by Schreuder (1984).

In the last instance both tasks involve exclusively movements of the vehicle, and in changes therein: longitudinal and lateral position on the road, and the time derivatives of these (speed, decelerations, accelerations. Furthermore, it should be stressed that taking part in traffic, particularly as the driver of a car, is primarily a decision making task, and not in the first place a visual task, as is often stated. This may be illustrated by the large influence on accident frequency of even a minor dose of alcohol: visual processing is not impaired at all, but the decision making capability is.

The decisions are made on the basis of visual information, as in present road transportation other means of information transfer are hardly used. Thus, road lighting is essential for the provision of the information also in the dark. The two tasks require specific information (the demand); the lighting installation provides the information (the supply). In order to permit adequate road transport, the supply should exceed or at least equal the demand (see Schreuder, 1977). In this way the function of road lighting can be described as providing the information that is needed for the different task elements in such a way that the demands are met.

The supply must meet the demand. To investigate whether such is the case, two ways may be followed. First, one may determine the (quality or quantity of) the road lighting, and look into the accident statistics to find out whether the requirements as regards the safety goals are met. This has been done on a large scale (OECD, 1971; CIE, 1960, 1990; Fisher & Hall, 1977; Schreuder, 1983, 1988a) resulting in the statement that "good" road lighting as compared with "poor" lighting may result in a reduction of about 30% in night-time injury accidents for major urban roads and for rural motorways. Three major questions are unanswered yet: what exactly is "good"; what types of road require (public) road lighting, and what is the percentage of accident reduction on other types of road. For answering these questions one needs to proceed differently. Here, the supply-and-demand model is split up in elements. The first step is to determine what are the visually relevant things (the visually critical elements) for different task aspects, e.g. for different manoeuvres that have to be performed to maintain course or to avoid obstacles. Therefore, several visually critical elements have to be defined (Adrian, 1976; CIE, 1981, 1990a; Padmos, 1984; Schreuder, 1984, 1988b; Walraven, 1980). More in particular, the run-of-the-road usually is more important than specific isolated objects. Recent studies make it clear that the recognition is even more important (Schreuder, 1985, 1986; Theewes 1989, 1989 a).

Extensive research and wide-spread practical experience show that the degree in which road lighting fulfills its traffic function can be quantified by the road surface luminance (the "brightness"). In addition, the uniformity of the luminance pattern and the glare are important, and obviously the visual guidance the driver may receive from the general road aspect including the lighting installation. See for a detailed discussion of these aspects: (De Boer ed., 1967 and Van Bommel & De Boer, 1980). Contrary to the opinion that was held for many decades - and that is held even now - it is NOT the illuminance (the amount of light falling into the surface) that is important. This implies that on road surfaces with a high light reflection, the luminous flux to be installed may be reduced. There is less agreement about the way the function for other road users - particularly pedestrians - are fulfilled. Sometimes one prefers the horizontal illuminance, sometimes the vertical or the semicylindrical illuminance, and again sometimes the luminance on the face of other pedestrians (Van den Brink & Tan, 1979; Schreuder, 1980; Caminada & Van Bommel, 1980, 1984).

As long as the question "what is good lighting" has not been answered, it is not possible to indicate what levels of luminance have to be recommended for different type of roads. Usually, one takes a value of 1 cd/m^2 as the minimum luminance for important traffic thoroughfares both in urban as in rural areas (CIE, 1977a; NSvV, 1990). For some types of roads an even higher value is often recommended; it should be noted, however, that the need for higher luminance levels seems to be more a matter of comfort and convenience than of traffic safety. For less important roads luminance levels of 0.5 cd/m^2 or lower are recommended. These recommendations of the CIE, the International Lighting Commission, are widely accepted and are used is most countries in the world. However, further research is urgently needed in this matter as the luminance values quoted above are in fact based mainly on practical experience. For this reason the CIE has established a working group to coordinate these activities. A framework for the required research is given in the symposium that was organized jointly by the TRB and the CIE (see TRB, 1984 and CIE, 1990a).

3. THE TECHNOLOGY OF ROAD LIGHTING

3.1. The light sources

Cost factors have always played a major role in road lighting policy. The costs of road lighting can be divided into three more or less equal parts: the costs of installation, the maintenance and lamp replacement costs, and the costs for electric energy (Tan, 1985). All costs are on a yearly base; we disregard other than electric lighting. The costs of the installation are more or less fixed for an installation of a certain type. The lamp costs and the energy costs, however, may vary considerably from one type of lamp to another - and from one location to another as well! Consequently, it is not possible to indicate one specific type of lamp that is the most economical. In fact, there are several families of lamps that are widely used for road lighting:

o incandescent lamps (standard or halogen);
o low-pressure mercury-vapour discharge lamps (fluorescent tubes "TL");
o high-pressure mercury-vapour discharge lamps (clear, halide or fluorescent, "HP", "HPI", "HPL");

- o low-pressure sodium-vapour discharge lamps ("SOX");
- o high-pressure sodium-vapour discharge lamps ("SON").

(It should be noted that several of the abbreviated notations used in this paper are registered trade marks e.g. "TL").

Each of these families consists of many types, that are similar in construction but differ in lumen output and consequently in dissipated wattage. These types are always indicated by the nominal wattage not taking into account the electrical losses in the control gear (the ballasts).

The luminous efficacy of the different lamp families and types is widely different. The incandescent lamps have an efficacy (expressed in lumen per Watt) of some 7 to 15; TL 45 to 95; HP 40 to 100; SOX 140 to over 200 and SON 90 to 140. Because, however, TL and HP lamps are cheap and SOX and especially SON expensive, all discharge lamps are widely in use. Incandescent lamps are not used any longer in modern installations for "normal" roads: they are widely used for floodlighting, for decorative lighting in ancient city centres etc.

Another important difference is the size of the lamps. This is obviously important for the size of the lanterns that must be able to accommodate them but also for the dimensions of the optics, as will be indicated in the next section. TL lamps are very large; so are the larger types of SOX lamps. HP and SON lamps and most incandescent lamps, however, are quite small. A comprehensive survey of the physical and technical details of lamps is given by Elenbaas (1972), for a more modern but more practical survey see Kaufman, (ed.), (1981).

The colour characteristics of the lamps are important. Incandescent lamps emit a continuous spectrum similar to the black-body radiation: as a result of the permissible temperature of the incandescent filament, most energy is emitted in the infrared region and in the adjoining red. resulting in the low efficacy and the yellowish colour of these lamps. Low-pressure vapour-discharge lamps emit essentially line spectra only. The lines of mercury are in the blue and green but particularly in the (invisible) ultraviolet. In order to increase the amount of visible light and thus the efficacy, fluorescent material is added that transforms the (monochromatic) ultraviolet light in (heterochromatic) visible light. The light of TL lamps is therefore not monochromatic any longer. Its actual colour can be selected in a wide range by applying appropriate fluorescent materials (the so-called phosphors).

The emission of low-pressure sodium-vapour discharges is monochromatic as well; the wavelength being about 590 nm. As this is in the middle of the visible part of the electromagnetic spectrum, the discharge is used as such. The result is a monochromatic light source with very high efficacy, but which is not capable of rendering any colours other than yellow (and black). The modern technology of SOX lamps is discussed by Sprengers et al. (1985) and Sprengers & Peters (1986). For applications for transport lighting the monochromatic light is not considered as a draw-back; for the reduction in the negative aspects of light trespass it is a great advantage. In fact, the application of low-pressure sodium lamps is considered as the most important single remedy for the interference with astronomical observation (Anon, 1985, 1985a; Crawford, 1983, 1985; IAU/CIE, 1980).

Electric discharges in vapour under high pressure are not monochromatic as a result of the widening of the spectral lines. The emission spectrum is not fully continuous; to a certain extent the original lines can be recognized in the spectrum of the lamp. In HP lamps it is thus possible to find the Hg-lines; therefore most HP lamps include just as TL lamps fluorescent powders (HPL). By adding other vapours additional lines can be introduced, improving the efficacy and the colour properties: the HPI lamps have additions of halogens. SON lamps show the original Sodium lines. Additives are not customary. In high pressure discharge lamps one must take into account the additional emission of the discharge tube, which usually will be extremely hot and will act as an incandescent body.

The fluorescent bulb is relatively large in respect to the discharge tube. Consequently, the optical system of the lantern must be designed in relation to this. It should be mentioned that many SON lamps have a diffusing bulb just in order to enlarge the light source.

Usually, only one type of lamp from only one family is the most economic street lighting lamp for specific purposes in specific locations. Often, this is not the lamp that is the least damaging for astronomical observations. Generally speaking it costs more to select the best type of lamp; sometimes, however, the addition is not large. Several recommendations for lamps to be applied near observation sites are published (see e.g. Anon, 1985; Crawford, 1985).

3.2. <u>The lanterns</u>

Street lighting lanterns have three major functions:

(i) controlling the light flux emitted by the lamps;

(ii) protection of the lighting equipment against atmospheric influences and damage by natural causes and by vandalism;

(iii) housing of the lighting equipment (lamps and electrical control gear like ballasts and fuses) and mounting it to the columns.

Lamps emit light in nearly all directions. A lighting scheme, however, requires usually a strict light control: one must ensure that the light is directed towards the objects to be lighted, and that no light shines in other directions, particularly in directions where it might cause glare or light trespass.

One may discern two ways of light control: simple screening and actually directing light in the desired directions. The first is simply a matter of shields and baffles; the effectiveness can be assessed by geometrical construction. Directing the light in the desired directions requires the application of optical means: mirrors, lenses or prisms. Basically, the optical control is realized by constructing a set of optical images of the light source (often but not always the discharge tube of the lamp) into the object to be illuminated. In the case of road lighting, this means constructing a number of optical images of the light source on the road surface in such a way that, taking into account the way the surface reflects the light, a certain desired distribution of the luminance of the road surface (as it present itself to an observer in a specified location) is realized. In case of the lighting of sport facilities, the same procedure is followed aimed at a specific distribution of the illuminance on the field.

The accuracy in which the light control can be realized depends on the divergence of the optical images. Here two factors have to be mentioned:

the natural spread of the lighting beams that results from the fact that usually the dimensions of the light source cannot be disregarded in relation to the dimensions of the optical imaging system - particularly to the focal length of the lenses or mirrors used. The fact that the dimensions of the light sources are not very small relative to the focal length, leads to a beam divergence (or beam aperture) that is essentially larger than zero. The simple laws of geometric optics do not apply. The second cause is the scatter due to the fact that in street lighting lanterns the optical systems are of a simple construction: restrictions in construction costs and dimensions of the lanterns result in an optical image with many faults. Lenses are usually made of pressed glass or extruded plastic elements and mirrors usually are formed of pressed aluminum. In all cases considerable errors - in optical sense - are unavoidable. These errors are added to the scatter of light from dust, grime, water etc. on the exterior surfaces of the lanterns. One might add here that the latter are reduced considerably when closed lanterns are used.

As a conclusion it must be stated that a considerable amount of light scatter can not be avoided. In case of the interference with astronomical observation it is primarily the light above the horizon that matters: that light may be reduced by applying lanterns that have a flat (transparent) lower surface, a "flat bowl" so to speak. In this case no light at all can be directed in directions over the horizon: a case of screening by means of the upper (opaque) part of the fitting. Open lanterns have a similar advantage. It should be pointed out that a flat closing window precludes applying refractors (lenses and/or prisms). Optically speaking lanterns with mirrors can be as effective as lanterns with refractors; preference of the one type over the other is primarily matter of costs and may differ considerably from one location to the other. Finally, open lanterns are not in use on a large scale for modern street lighting applications because their efficiency is rapidly reduced as a result of soiling and corrosion.

In this respect, the calculations of Waldram should be mentioned. On the basis of the light distribution of lanterns, and of the atmospheric scatter, he assessed the contribution of different parts of the light distribution diagram, and he showed clearly that cut-off lanterns are to be preferred near astronomical observatories. The difference with non-cut-off lanterns was, however, rather moderate. The reason for this seems to be the fact that at that time, only very shiny road surfaces were used in Britain. As we will explain later, such road surfaces are not used any longer, primarily because they tend to become very slippery when wet. One might expect that nowadays the advantage of cut-off lanterns will be more pronounced than in Waldram's days (Waldram, 1972).

The other two functions of the lantern (protection and housing) speak for themselves; they do not need to be discussed here. The different aspects of street lighting lanterns, their design, construction, installation and maintenance are discussed in detail in the relevant literature (see e.g. De Boer (ed.), 1967; Van Bommel & De Boer, 1980).

3.3. <u>The road surface</u>

We have indicated earlier that the most important criterion of quality for road lighting installations is the (average) road surface luminance. Now, the luminance of a non-emitting surface depends upon two quantities: the amount of light falling into the surface (the illuminance or illumination, expressed in lux or lumen/m^2) and the reflective properties of the surface. In many cases the amount of reflected light - and consequently the luminance - depends on the directions of light incidence and of observation - the "reflection factor" actually is a tensor. Road surfaces show this effect to a high degree, as a result of the glancing observation angles that are inherent to motorized road traffic, particularly when they are damp or wet - even the so-called diffuse or coarse road surfaces!

In designing effective road lighting installations, this effect is used to a considerable degree. The lanterns are designed in such a way that most of the light is emitted in directions close to, and lower than the horizon. In this way, the highest use is made from these specular characteristics of the road. Lanterns showing such emission (or luminous intensity distributions) are used very widely in continental Europe, particularly in roads with a traffic function. In residential areas, and as a matter of fact in the rest of the world for all roads, the so-called "non-cut-off" lanterns are predominant. The reason is that it was often assumed that by letting the light come out of the lantern in a nearly horizontal direction, the spacing between the successive lanterns could be large without causing dark patches between them. Both practical experience with modern, skid-proof road surfaces and calculations prove conclusively that this assumption is incorrect (see e.g. De Boer (ed.), 1967; CIE, 1976; CIE/PIARC, 1984; OECD, 1984; SCW, 1984). In fact, there really is no support at all using non-cutoff lanterns in road lighting for traffic routes. For residential areas, shopping areas and pedestrian precincts the matter is somewhat different. Here, one prefers a lively surrounding that is focussed on the needs for pedestrians to be able to see properly. Non-cut-off lanterns may contribute to such lively surroundings. However, such non-cut-off lanterns may contribute considerably to light trespass. A closer examination of the lighting and visual aspects involved will show that also in such situations and locations the use of non-cut-off lanterns is of little use. However, in such situations and locations the contribution of the street lighting to light trespass usually is small and often negligible as compared to the contribution of other light sources a such as shop windows, floodlighting of buildings, sports stadium lighting etc.

As regards the road surface, we come to the conclusion that reducing the reflection factor (i.e. selecting a darker surface) does not reduce the light spill; contrary to this, the light spill will increase as a larger lamp (a higher lumen output) must be used in order to arrive at the same road surface luminance.

4. OTHER SOURCES OF LIGHT POLLUTION

The measurements quoted by Finch et al. (1979) clearly show that the contribution of other light sources to the light pollution often equals or even surpasses that of the road lighting. A similar result might be deduced from measurements quoted in Anon (1985), where the extinction of (part of) the street lighting of a city near an observatory resulted in a considerable reduction (of about 30%) of the sky glow; the majority of the sky glow, however, seems to have come from other sources.

The studies of Crawford (1983, 1985) suggest that billboard lighting does contribute to a considerable degree towards the sky glow. This seems to be a typical case for the (South-Western) USA; there are reasons to believe that in many European locations the sports stadium lighting is the primary source of stray-light.

Finally, the car headlamps presumably will contribute considerably to the light pollution. Studies in this area are urgently needed, particularly as many urge to increase the intensity of car headlamps. It should be noted that one might doubt whether this urge will result in positive effects for road safety! (Schreuder, 1976).

5. REMEDIAL MEASURES

The considerations given in the foregoing sections on road lighting and related subjects clearly point towards several possibilities to avoid or at least to reduce the disturbance for astronomical observations caused by light pollution:
(I) reduce the total amount of light;
(II) reduce the light emitted above the horizon;
(III) reduce the amount of reflected light;
(IV) reduce the width in the electromagnetic spectrum where light is emitted.

A. Switching out the lights

This obviously is the final solution as regards the astronomical observations. However, it cannot be done in full as other equally important aspects of our social life require night-time activities and consequently artificial light at night. Nevertheless, a fair number of light sources can be switched out without any damage; furthermore, in many cases light sources can be replaced by smaller sources emitting less light (other, even more effective possibilities are discussed further on). An important way to improve the situation is to guarantee that most lights, particularly those that contribute most to light pollution like sports stadium lighting, are not used after a certain time. Many local by-laws and ordinances impose time restrictions in the use of such lighting installations (Anon, 1981, 1982).

B. Using monochromatic light

The most effective way available at present to reduce interference is the use of (quasi)monochromatic light sources, more in particular the use of low-pressure sodium-vapour (SOX) lamps. These lamps emit a very narrow spectral band (nearly a line!) in the yellow part of the spectrum. Two advantages are obvious: all other spectral regions are not involved, so that observations in other spectral regions - either photography or spectroscopy - are hardly affected. Secondly, as the yellow line is close to the maximum of the sensitivity of the eye, the luminous efficacy of low pressure sodium lamps is high - they are far the most efficient light sources available at present (Sprengers & Peters, 1986). Finally they hardly do emit any radiation in the non-visible parts of the spectrum. On these grounds, the application of low-pressure sodium lamps near sites of astronomical observatories is universally recommended (see e.g. Anon, 1985, 1985a; CIE, 1978; Crawford, 1983, 1985; IAU/CIE, 1980); apart from the fact that low-pressure sodium lamps usually prove to be a very economic proposition to begin with!

C. Light control

We discussed in detail the possibilities to reduce light spill by means of light control. In simple terms this means preventing light being emitted above the horizon; more precisely it means that the light is directed to the objects to be illuminated. As regards the road lighting, the measures to reduce light trespass are very similar to those that enhance the (economic) efficiency of the lighting installation. The reason that lanterns with optimal light control are not applied universally is twofold: primarily lighting design schemes employing such lanterns usually require higher initial costs whereas the economic profits are found only in the longer term - a matter that is often prohibitive in political decisions -, secondly setting up such schemes requires a high degree of light-technical skill. In this respect it is strange to have to note that the education at all levels of schooling in light-technical skills and sciences is quite limited in spite of the fact that both the general public and the political and administrative bodies worldwide are aware of the environmental and social aspects of good lighting versus excessive lighting (Begemann, 1986; Schreuder, 1986a).

D. <u>Reduction of reflection</u>
Theoretically speaking, this remedy is just as important as the two that have been mentioned earlier. In practice, however, the possibilities to manipulate the reflective characteristics in the real world are very limited indeed. We indicated also that reducing the reflection of the road surface is counterproductive in this respect.

The effect of air pollution might be included here. Air pollution often creates haze, or even clouds of smoke and dust; the light from lighting installations partly is scattered in these clouds, and partly absorbed. The net result of air pollution on the sky glow, particularly that of far away observatories can therefore be positive or negative. In some cases the sky glow may increase (when the scatter predominates), in other cases the net result may be a decrease of the sky glow (when the absorption predominates) (Anon, 1985).

E. <u>Filtering the light</u>
Finally, reducing the width of the spectral range of the emitted light is an effective countermeasure against the interference by light of astronomical observations, particularly in those cases where the use of low-pressure sodium lamps is impossible or undesirable. Here the emission of radiation near the ends of the visible region of the spectrum, e.g. the far blue and the far red can be restricted by filters. Radiation emitted in these regions contributes only little to the visual sensation (more precisely to the luminance), but it may cause considerable disturbance for certain types of astronomical observations, e.g. photographical observations where the near-ultraviolet is used, and to infrared measurements. Therefore, most by-laws and ordinances for areas near observatories restrict the emission of radiation in these spectral regions. This can be done quite simply by means of filters that can be incorporated in the lanterns (Anon, 1982).

6. <u>THE FUTURE</u>

It is relatively simple to indicate a number of remedial measures with which the disturbance of light pollution for the astronomical observations can be eliminated or at least diminished. It is not so simple, however, to indicate how these should (or could!) be implemented.

The first obstacle seems to be the lack of knowledge of the relevant aspects from the side of the authorities. One should try to convince the authorities that the cause for the astronomers is a legitimate one, as much so as the cause for other groups of interest. Furthermore, one should try and persuade the authorities that the means to fulfill the requirements of the astronomy are available, that they are within reasonable limits of what one can do (and will pay!), and, finally, that in a number of cases the solutions that are preferable for the astronomy are economically speaking advantageous as well (Schreuder, 1987).

A second obstacle is the restricted level of expertise of many lighting engineers. The scientific level of the lighting field as an engineering discipline is quite high, but unfortunately the persons in the field who have to take care of the lighting installation are often not educated to a high technical level. This is even more the case with many decision makers who are responsible for the political decisions regarding lighting and the money to spend on it! (Schreuder, 1986a; Begemann, 1986).

A further obstacle to the solution of the light pollution problems is the lack of understanding amongst the two communities involved: the lighting engineers and the astronomers. Notwithstanding the co-operation that did lead a.o. to the important joint report on light pollution (IAU/CIE, 1980) and, more recently, to the IAU colloquium 112 that was organised jointly by IAU and CIE, and was being held in Washington DC in August 1988 (Anon, 1988), there is still some mutual misunderstanding. However, when one looks at the literature and particularly at the statements of the IAU and the CIE respectively, it is easy to see that the two communities grow towards each other. This favorable development does not imply, however, that the two groups of professional experts always do understand each other. A continuing contact between the groups of experts seems to be urgently required.

A major new development in this resect is the founding of a CIE Technical Committee TC 4.21 that will study, in the context of Division 4 (on Lighting and Signalling for Transport) of CIE, the matter in close co-operation with IAU. At present, the final steps are being made to launch this TC. The membership includes several top astronomers and several top lighting engineers from six countries in three continents. It is expected that this TC will set up recommendations for the reduction of interference by light of astronomical observations (the title of the TC) by means of proposals for technical, administrative and economical measures.

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A MAP OF THE MOON WITH NAMES FOR CRATERS

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1. The rules for naming craters on the surface of the moon, on the smooth flat areas , called "mares" and on the mountain on the surface of the moon date back to a Jesuit astronomer of the sixteenth century. He wrote a book entitled "The Almagestum Novum" in which he stated:

a)Craters on the face of the moon shall be named after deceased astronomers. (This has been changed slightly in recent years by the International Astronomical Union to include other scientists save astronomers, astronauts, and even men like Martin Luther.

b) Maria or flat smooth areas which were called "seas" by Galileo were named after moods or frames of mind. These have been kept except for one or two exceptions like the Moscow Sea.

c) Mountains on the moon have been named after mountains on the earth: Like the Alps. the Apennines, etc.

2. The maps shown here contain all of the items marked caccording to their positions in the tables. Look for those that contain names of Japanese astronomers. Look up their history in a book like "AHistory of Japanese Astronomy" S. Nakayama (1989).

3. Later we shall talk about the methods of Mercator Projection which these maps follow.

Newly Adopted Far-Side

Abbe	58S	175E
Abul Wafa	2N	117E
Aitken	17S	173E
Al-Biruni	18N	93E
Alden	24S	111E
Alekhin	68S	130W
Alter	19N	108W
Amici	10S	172W
Anders	42S	144W
Anderson	16N	171E
Antoniadi	69S	173W
Apollo	37S	153W
Appleton	37N	158E
Arrhenius	55S	91W
Artamonov	26N	104E
Artem'ev	10N	145W
Avicenna	40N	97W
Avogadro	64N	165E
Babcock	4N	94E
Backlund	16S	103E
Baldet	54S	151W
Banachiewicz	51N	135W
Barbier	24S	158E
Barringer	29S	151W
Bartels	24N	90W
Becquerel	41N	129E
Becvar	2S	125E
Beijerinck	13S	152E
Bell	22N	96W
Bellingshausen	61S	164W
Belopolsky	18S	128W
Belyaev	23N	143E
Bergstrand	19S	176E
Berkner	25N	105W
Berlage	64S	164W
Bhabha	56S	165W
Birkeland	30S	174E
Birkhoff	59N	148W
Bjerknes	38S	113E
Blazhko	31N	148W
Bobone	26N	132W
Boltzmann	55S	115W
Bolyai	34S	125E
Borman	39S	149W
Bose	54S	170W
Boyle	54S	178E
Bragg	42N	103W
Brashear	74S	172W
Bredikhin	17N	158W
Bridgman	44N	137E
Brouwer	36S	125W
Brunner	10S	91E
Buffon	41S	134W
Buisson	1S	113E
Butlerov	9N	109W
Buys-Ballot	21N	175E
Cabannes	61S	171W
Cajori	48S	168E
Campbell	45N	152E
Cannizzaro	55N	100W
Cantor	38N	118E
Carnot	52N	144W
Carver	43S	127E
Cassegrain	52S	113E
Ceraski	49S	141E
Chaffee	39S	155W
Chamberlin	59S	96E
Champollion	37N	175E
Chandler	44N	171E
Chang Heng	19N	112E
Chant	41S	110W
Chaplygin	6S	150E
Chapman	50N	101W
Chappell	55N	178W
Charlier	36N	132W
Chaucer	3N	140W
Chauvenet	11S	137E
Chebyshev	34S	133W
Chernyshev	47N	174E
Chrétien	47S	163E

Clark	38S	119E
Coblentz	38S	126E
Cockcroft	30N	164W
Compton	55N	104E
Comrie	23N	113W
Comstock	21N	122W
Congreve	0	168W
Cooper	53N	176E
Coriolis	0	172E
Coulomb	56N	126W
Crocco	47S	150E
Crommelin	68S	147W
Crookes	11S	165W
Curie	23S	92E
Cyrano	20S	157E
Daedalus	6S	180
D'Alembert	52N	164E
Danjon	11S	123E
Dante	25N	180
Das	27S	138W
Davisson	38S	175W
Dawson	67S	134W
Debye	50N	177W
De Forest	76S	162W
Dellinger	7S	140E
Delporte	16S	121E
Denning	16S	143E
De Roy	55S	99W
Deutsch	24N	111E
De Vries	20S	177W
Dewar	3S	166E
Dirichlet	10N	151W
Donner	31S	98E
Doppler	13S	160W
Douglass	35N	122W
Dreyer	10N	97E
Drude	39S	91W
Dryden	33S	157W
Dufay	5N	170E
Dugan	65N	103E
Dunér	45N	179E
Dyson	61N	121W
Dziewulski	21N	99E
Ehrlich	41N	172W
Eijkman	62S	141W
Einthoven	5S	110E
Ellerman	26S	121W
Ellison	55N	108W
Elvey	9N	101W
Emden	63N	176W
Engelhardt	5N	159W
Eötvös	36S	134E
Erro	6N	98E
Esnault-Pelterie	47N	142W
Espin	28N	109E
Evans	10S	134W
Evdokimov	35N	153W
Evershed	36N	160W
Fabry	43N	100E
Fechner	59S	125E
Fenyi	45S	105W
Feoktistov	31N	140E
Fermi	20S	112E
Fersman	18N	126W
Firsov	4N	112E
Fitzgerald	27N	172W
Fizeau	58S	133W
Fleming	15N	109E
Focas	34S	94W
Foster	23N	142W
Fowler	43N	145W
Freundlich	25N	171E
Fridman	13S	127W
Froelich	80N	110W
Frost	37N	119W

Gadomski	36N	147W
Gagarin	20S	150E
Galois	16S	153W
Gamow	65N	143E
Gansky	10S	97E
Ganswindt	79S	110E
Garavito	48S	157E
Gavrilov	17N	131E
Geiger	14S	158E
Gerasimovic	23S	124W
Gernsback	36S	99E
Ginzel	14N	97E
Glasenap	2S	138E
Golitsyn	25S	105W
Golovin	40N	161E
Grachev	3S	108W
Green	4N	133E
Gregory	2N	127E
Grigg	13N	130W
Grissom	48S	149W
Grotrian	66S	128E
Gullstrand	45N	130W
Guthnick	48S	94W
Guyot	11N	117E
Hagen	48S	135E
Harriot	33N	114E
Hartmann	3N	135E
Harvey	19N	147W
Hatanaka	29N	122W
Hayford	13N	176W
Healy	32N	111W
Heaviside	10S	167E
Hedin	62N	136E
Helberg	22N	102W
Henderson	5N	152E
Hendrix	48S	161W
Henyey	13N	152W
Hertz	13N	104E
Hertzsprung	0	130W
Hess	54S	174E
Heymans	75N	145W
Hilbert	18S	108E
Hippocrates	71N	146W
Hirayama	6S	93E
Hoffmeister	15N	137E
Hogg	34N	122E
Hohmann	18S	94W
Holetschek	28S	151E
Houzeau	18S	124W
Hutton	37N	169E
Ibn Yunus	14N	91E
Icarus	6S	173W
Idelson	81S	114E
Ingalls	26N	153W
Ingenii, Mare	34S	163E
Innes	28N	119E
Izsak	23S	117E
Jackson	22N	163W
Jenner	42S	96E
Joffe	15S	129W
Joule	27N	144W
Kamerlingh Onnes	15N	116W
Karpinsky	73N	166E
Kearons	12S	113W
Keeler	10S	162E
Kekulé	16N	138W
Khwolson	14S	112E
Kibal'chich	2N	147W
Kidinnu	36N	123E
Kimura	57S	118E
King	5N	120E
Kirkwood	69N	157W
Kleimenov	33S	141W
Klute	37N	142W
Koch	43S	150E

Kohlschütter
Kolhörster
Komarov
Kondratyuk
Konstantinov
Kopff
Korolev
Kostinsky
Kovalevskaya
Kovalsky
Kramers
Krasovsky
Krylov
Kugler
Kulik
Kuo Shou Ching
Kurchatov
Lacchini
Lamarck
Lamb
Lampland
Landau
Lane
Langemak
Langevin
Langmuir
Larmor
Laue
Lauritsen
Leavitt
Lebedev
Lebedinsky
Leeuwenhoek
Leibnitz
Lemaitre
Lenz
Leonov
Leucippos
Leuschner
Levi-Civita
Lewis
Ley
Lindblad
Litke
Lobachevsky
Lodygin
Lorentz
Love
Lovelace
Lovell
Lowell
Lucretius
Lundmark
Lyman
Mach
Maksutov
Malyi
Mandel'shtam
Marci
Marconi
Mariotte
Maunder
McKellar
McLaughlin
McMath
McNally
Mees
Meggers
Meitner
Mendel
Mendeleev
Merrill
Mesentsev
Meshchersky
Metchnikov
Michelson

Names on the Moon

15N	154E
10N	115W
25N	153E
15S	115E
20N	159E
17S	90W
5S	157W
14N	118E
31N	129W
22S	101E
53N	128W
4N	176W
35N	167W
53S	104E
42N	155W
8N	134W
38N	142E
41N	107W
51S	158E
43S	101E
31S	131E
42N	119W
9S	132E
10S	119E
44N	162E
36S	129W
32N	180
28N	97W
27S	96E
46S	140W
48S	108E
8N	165W
30S	179W
38S	178E
62S	150W
3N	102W
19N	148E
29N	116W
1N	109W
24S	143E
19S	114W
43N	154E
70N	99W
17S	123E
10N	113E
18S	147W
34N	100W
6S	129E
82N	107W
37S	142W
13S	103W
9S	121W
39S	152E
65S	162E
18N	149W
41S	169W
22N	105E
4N	156E
22N	169W
9S	145E
29S	140W
14S	94W
16S	171W
47N	93W
15N	167W
22N	127W
14N	96W
24N	123E
11S	113E
49S	110W
6N	141E
75N	116W
72N	129W
12N	125E
11S	149W
6N	121W

Milankovic	77N	170E
Millikan	47N	121E
Mills	9N	156E
Milne	31S	113E
Mineur	25N	162W
Minkowski	56S	145W
Mitra	18N	155W
Möbius	16N	101E
Mohorovicic	19S	165W
Moiseev	9N	103E
Montgolfier	47N	160W
Moore	37N	178W
Morozov	5N	127E
Morse	22N	175W
Moulton	61S	97E
Nagaoka	20N	154E
Nassau	25S	177E
Nernst	36N	95W
Neujmin	27S	125E
Niepce	72N	120W
Nijland	33N	134E
Nikolaev	35N	151E
Nishina	45S	171W
Nobel	15N	101W
Nöther	66N	114W
Numerov	71S	161W
Nusl	32N	167E
Obruchev	39S	162E
O'Day	31S	157E
Ohm	18N	114W
Olcott	20N	117E
Omar Khayyam	58N	102W
Oppenheimer	35S	166W
Oresme	43S	169E
Orlov	26S	175W
Ostwald	11N	122E
Paneth	63N	95W
Pannekoek	4S	141E
Papaleksi	10N	164E
Paracelsus	23S	163E
Paraskevopoulos	50N	150W
Parenago	26N	109W
Parkhurst	34S	103E
Parsons	37N	171W
Paschen	14S	141W
Pasteur	12S	105E
Pauli	45S	137E
Pavlov	29S	142E
Pawsey	44N	145E
Pease	13N	106W
Perelman	24S	106E
Perepelkin	10S	128E
Perkin	47N	176W
Perrine	42N	129W
Petrie	45N	108E
Petropavlovsky	37N	115W
Petzval	63S	113W
Pirquet	20S	140E
Pizzetti	35S	119E
Planck	57S	135E
Planck (Rima)	65S, 129E to 54S, 125E	
Plaskett	82N	175E
Plummer	25S	155W
Pogson	42S	111E
Poincaré	57S	161E
Poinsot	79N	147W
Polzunov	26N	115E
Popov	17N	99E
Poynting	17N	133W
Prager	4S	131E
Prandtl	60S	141E
Priestley	57S	108E
Purkyne	1S	95E
Quételet	43N	135W

Racah	14S	180
Raimond	14N	159W
Ramsay	40S	145E
Rasumov	39N	114W
Rayet	45N	114E
Rayleigh	67S	179E
Ricco	75N	177E
Riedel	49S	140W
Riemann	40N	96E
Rittenhouse	74S	107E
Ritz	15S	92E
Roberts	71N	175W
Robertson	22N	105W
Roche	42S	135E
Roshdestvensky	86N	155W
Rowland	57N	163W
Rumford	29S	170W
Rydberg	47S	96W
Saenger	4N	102E
Safarik	10N	177E
Saha	2S	103E
St. John	10N	150E
Sanford	32N	139W
Sarton	49N	121W
Scaliger	27S	109E
Schaeberle	26S	117E
Schjellerup	69N	157E
Schlesinger	47N	138W
Schliemann	2S	155E
Schneller	42N	164W
Schönfeld	45N	98W
Schorr	19S	90E
Schrödinger	75S	133E
Schrödinger (Rima)	62S, 99E to 71S, 114E	
Schuster	4N	147E
Schwarzschild	71N	120E
Seares	74N	145E
Sechenov	7S	143W
Segers	47N	128E
Seidel	33S	152E
Seyfert	29N	114E
Shajn	33N	172E
Sharonov	13N	173E
Shatalov	24N	140E
Shi Shen	76N	105E
Shternberg	19N	117W
Siedentopf	22N	135E
Sierpinski	27S	155E
Sisakyan	41N	109E
Sklodowska	18S	96E
Slipher	50N	160E
Smoluchowski	60N	96W
Sniadecki	22S	169W
Sommerfeld	65N	161W
Spencer Jones	13N	166E
Spiru Haret	59S	176W
Stark	25S	134E
Stebbins	65N	143W
Stefan	46N	109W
Stein	7N	179E
Steklov	37S	105W
Steno	33N	162E
Stetson	40S	119W
Stoletov	45N	155W
Stoney	56S	156W
Störmer	57N	145E
Stratton	6S	165E
Strömgren	22S	133W
Subbotin	29S	135E

Sumner	37N	109E
Sundman	11N	91W
Swann	52N	112E
Szilard	34N	106E
Teisserenc	32N	137W
Ten Bruggencate	9S	134E
Tereshkova	28N	145E
Tesla	38N	125E
Thiel	40N	134W
Thiessen	75N	169W
Thomson	32S	166E
Tihomirov	25N	162E
Tikhov	62N	172E
Tiling	52S	132W
Timiryazev	5S	147W
Titius	27S	101E
Titov	28N	150E
Trumpler	28N	168E
Tsander	5N	149W
Tsu Chung Chi	17N	144E
Tyndall	35S	117E
Valier	7N	174E
Van de Graaff	27S	172E
Van den Bergh	31N	159W
Van der Waals	44S	119E
Van Gent	16N	160E
Van Maanen	36N	127E
Van Rhijn	52N	145E
Van't Hoff	62N	133W
Van Wijk	63S	119E
Vashakidze	44N	93E
Vavilov	1S	139W
Vening Meinesz	0	163E
Ventris	5S	158E
Vernadsky	23N	130E
Vesalius	3S	115E
Vestine	34N	94E
Vetchinkin	10N	131E
Vil'ev	6S	144E
Volterra	57N	131E
Von der Pahlen	25S	133W
Von Karman	45S	176E
Von Neumann	40N	153E
Von Zeipel	42N	142W
Walker	26S	162W
Wan-Hoo	11S	139W
Waterman	26S	128E
Watson	63S	124W
Weber	50N	124W
Wegener	45N	113W
Wells, H. G.	41N	122E
Wexler	69S	90E
Weyl	16N	120W
White	45S	160W
Wiechert	84S	165E
Wiener	41N	146E
Wilsing	22S	155W
Winkler	42N	179W
Winlock	35N	106W
Woltjer	45N	160W
Wood	44N	121W
Wyld	1S	98E
Yablochkov	61N	127E
Yamamoto	59N	161E
Zeeman	75S	135W
Zelinsky	29S	167E
Zernike	18N	168E
Zhiritsky	25S	120E
Zhukovsky	7N	167W
Zinger	57N	176E
Zsigmondy	59N	105W

This list gives approximate latitudes and longitudes, in degrees. The nomenclature is that adopted (subject to official corrections) by the International Astronomical Union in August, 1970. Known corrections up to early October, 1970, have been made in the map and list, but the data are liable to later revisions.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

INDEX OF LUNAR FORMATIONS

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PREPARED UNDER THE DIRECTION OF THE DEPARTMENT OF DEFENSE BY THE AERONAUTICAL CHART AND INFORMATION CENTER, UNITED STATES AIR FORCE FOR THE NATIONAL AERONAUTICS AND SPACE ADMINISTRATION.

INDEX OF LUNAR FORMATIONS

This report contains an alphabetical listing and feature location of all primary lunar names which have been approved by the International Astronomical Union (IAU).

Sources used for this list were: (1) "Named Lunar Formations" by Blagg and Müller, approved by the IAU in 1935, (2) Communications of the University of Arizona, Lunar and Planetary Laboratory "The System of Lunar Craters, Quadrants I, II, III and IV" which include names approved by the IAU in 1961 and 1964 and (3) Report on Lunar Nomenclature by the Working Group of Commission 17 of the IAU and approved by the IAU in 1970.

Coordinates of listed features are given to the nearest one degree intersection.

Users of this list are requested to forward any noticed discrepancies to ACIC (PDN), 2nd & Arsenal Sts., St. Louis, Missouri, 63118.

INDEX OF LUNAR FORMATIONS

Compiled by ACIC, 1 October 1971

CRATERS		
Abbe	58S	175E
Abel	35S	85E
Abenezra	21S	12E
Abulfeda	14S	14E
Abul Wafa	2N	117E
Adams	32S	69E
Agatharchides	20S	31W
Agrippa	4N	10E
Airy	18S	6E
Aitken	17S	173E
Albategnius	11S	4E
Al-Biruni	18N	93E
Alden	24S	111E
Aldrin	1N	22E
Alekhin	68S	131W
Alexander	40N	13E
Alfraganus	5S	19E
Alhazen	16N	72E
Aliacensis	31S	5E
Almanon	17S	15E
Alpetragius	16S	5W
Alphonsus	14S	3W
Alter	19N	108W
Amici	10S	172W
Amundsen	85S	85E
Anaxagoras	73N	10W
Anaximander	67N	51W
Anaximenes	73N	45W
Anděl	10S	12E
Anders	42S	144W
Anderson	16S	171E
Angström	30N	42W
Ansgarius	13S	79E
Antoniadi	69S	173W
Apianus	27S	8E
Apollo	35S	153W
Apollonius	5N	61E
Appleton	37N	158E
Arago	6N	21E
Aratus	24N	5E
Archimedes	30N	4W
Archytas	59N	5E
Argelander	17S	6E
Ariadaeus	5N	17E
Aristarchus	24N	48W
Aristillus	34N	1E
Aristoteles	50N	17E
Armstrong	1N	25E
Arnold	67N	36E

CRATERS		
Arrhenius	55S	91W
Artamonov	26N	104E
Artem'ev	10N	145W
Arzachel	18S	2W
Asclepi	55S	26E
Aston	33N	88W
Atlas	47N	44E
Autolycus	31N	1E
Auwers	15N	17E
Auzout	10N	64E
Avicenna	40N	97W
Avogadro	64N	165E
Azophi	22S	13E
Baade	45S	82W
Babbage	59N	57W
Baco	51S	19E
Babcock	4N	94E
Backlund	16S	103E
Baillaud	74N	38E
Bailly	67S	69W
Baily	50N	30E
Balboa	19N	83W
Baldet	54S	151W
Ball	36S	8W
Balmer	20S	71E
Banachiewicz	6N	80E
Barbier	24S	158E
Barnard	30S	86E
Barocius	45S	17E
Barringer	29S	151W
Barrow	71N	8E
Bartels	24N	90W
Bayer	52S	35W
Beaumont	18S	29E
Becquerel	41N	129E
Bečvar	2S	125E
Beer	27N	9W
Behaim	17S	79E
Beijerinck	13S	152E
Belkovich	62N	90E
Bell	22N	96W
Bellingshausen	61S	164W
Bellot	12S	48E
Belopolsky	18S	128W
Belyaev	23N	143E
Bergstrand	19S	176E
Berkner	25N	105W
Berlage	64S	164W

CRATERS		
Bernouilli	35N	61E
Berosus	34N	70E
Berzelius	37N	51E
Bessarion	15N	37W
Bessel	22N	18E
Bettinus	63S	45W S.J.
Bhabha	56S	165W
Bianchini	49N	34W
Biela	55S	51E
Billy	14S	50W * SJ
Biot	23S	51E
Birkeland	30S	174E
Birkhoff	59N	148W
Birmingham	65N	11W
Birt	22S	9W
Bjerknes	38S	113E
Blagg	1N	1E
Blancanus	64S	21W SJ
Blanchinus	25S	3E
Blazhko	31N	148W
Bobone	26N	132W
Bode	7N	2W
Boguslawsky	73S	43E
Bohnenberger	16S	40E
Bohr	13N	86W
Boltzmann	75S	90W
Bolyai	34S	125E
G. Bond	32N	36E
W. Bond	65N	4E
Bonpland	8S	17W
Boole	64N	87W
Borda	25S	47E
Borman	39S	149W
Boscovich	10N	11E SJ
Bose	54S	170W
Boss	46N	88E
Bouguer	52N	36W
Boussingault	70S	55E
Boyle	54S	178E
Bragg	42N	103W
Brashear	74S	171W
Brayley	21N	37W
Bredikhin	17N	158W
Breislak	48S	18E
Brenner	39S	39E
Brianchon	75N	87W
Bridgman	44N	137E
Briggs	26N	69W
Brisbane	49S	69E

CRATERS		
Brouwer	36S	125W
Brown	46S	18W
Bruce	1N	0
Bruggencate	9S	134E
Brunner	10S	91E
Buch	39S	18E
Buffon	41S	134W
Buisson	1S	113E
Bullialdus	21S	22W
Bunsen	42N	86W
Burckhardt	31N	57E
Bürg	45N	28E
Burnham	14S	7E
Büsching	38S	20E
Butlerov	12N	110W
Buys-Ballot	21N	175E
Byrd	85N	10E
Byrgius	25S	65W
Cabannes	61S	171W
Cabeus	85S	41W SJ
Cajori	48S	168E
Calippus	39N	11E
Campanus	28S	28W
Campbell	45N	152E
Cannizzaro	55N	100W
Cannon	20N	81E
Cantor	38N	118E
Capella	8S	35E
Capuanus	34S	27W
Cardanus	13N	72W
Carlini	34N	24W
Carnot	52N	144W
Carpenter	70N	51W
Carrington	44N	62E
Carver	44S	127E
Casatus	73S	30W
Cassegrain	52S	113E
Cassini	40N	5E
Catalán	46S	87W
Catharina	18S	24E
Cauchy	10N	39E
Cavalerius	5N	67W
Cavendish	25S	54W
Cayley	4N	15E
Celsius	14S	20E
Censorinus	0	33E
Cepheus	41N	46E
Ceraski	49S	141E
Chacornac	30N	32E
Chaffee	39S	155W
Challis	80N	9E

CRATERS		
Chamberlin	59S	96E
Champollion	37N	175E
Chandler	44N	171E
Chang Heng	19N	112E
Chant	41S	110W
Chaplygin	6S	150E
Chapman	50N	101W
Chappell	55N	179W
Charlier	36N	132W
Chaucer	3N	140W
Chauvenet	11S	137E
Chebyshev	34S	133W
Chernyshev	47N	174E
Chevallier	45N	51E
Chladni	4N	1E
Chrétien	47S	163E
Cichus	33S	21W
Clairaut	48S	14E
Clark	38S	119E
Clausius	37S	44W
Clavius	58S	14W SJ
Cleomedes	28N	56E
Cleostratus	60N	77W
Coblentz	38S	126E
Cockcroft	30N	164W
Collins	1N	24E
Colombo	15S	46E
Compton	56N	104E
Comrie	23N	113W
Comstock	21N	122W
Condorcet	12N	70E
Congreve	0	168W
Conon	22N	2E
Cook	17S	49E
Copernicus	10N	20W
Cooper	53N	176E
Coriolis	0	172E
Coulomb	54N	115W
Cremona	67N	90W
Crocco	47S	150E
Crommelin	68S	148W
Crookes	11S	165W
Crozier	13S	51E
Crüger	17S	67W
Curie	23S	92E
Curtius	67S	4E
Cusanus	72N	70E
Cuvier	50S	10E
Cyrano	20S	157E
Cyrillus	13S	24E
Cysatus	66S	6W SJ

CRATERS		
Daedalus	6S	180
Daguerre	12S	34E
D'Alembert	52N	164E
Dalton	17N	84W
Damoiseau	5S	61W
Daniell	35N	31E
Danjon	11S	124E
Dante	25N	180
Darney	15S	24W
d'Arrest	2N	15E
Darwin	20S	69W
Das	27S	138W
da Vinci	9N	45E
Davisson	38S	175W
Davy	12S	8W
Dawes	17N	26E
Dawson	67S	134W
Debes	30N	52E
Debye	50N	177W
Dechen	46N	68W
De Forest	76S	162W
de Gasparis	26S	51W
Delambre	2S	17E
de la Rue	59N	53E
Delaunay	22S	3E
Delisle	30N	35W
Dellinger	7S	140E
Delmotte	27N	60E
Delporte	16S	121E
Deluc	55S	3W
Dembowski	3N	7E
Democritus	62N	35E
Demonax	78S	59E
de Morgan	3N	15E
Denning	16S	143E
De Roy	55S	99W
Desargues	70N	73W
Descartes	12S	16E
Deseilligny	21N	21E
de Sitter	80N	38E
Deslandres	32S	5W
Deutsch	24N	111E
de Vico	20S	60W SJ
De Vries	20S	177W
Dewar	3S	166E
Dionysius	3N	17E
Diophantus	28N	34W
Dirichlet	10N	151W
Dollond	11S	14E
Donati	21S	5E
Donner	31S	98E
Doppelmayer	28S	41W

CRATERS

Doppler	13S	160W
Douglass	35N	122W
Dove	47S	31E
Draper	18N	22W
Drebbel	41S	49W
Dreyer	10N	97E
Drude	39S	92W
Dryden	33S	157W
Drygalski	79S	82W
Dubiago	5N	70E
Dufay	5N	170E
Dugan	65N	103E
Dunér	45N	179E
Dunthorne	30S	32W
Dyson	61N	121W
Dziewulski	21N	99E
Eddington	22N	72W
Edison	25N	100E
Egede	49N	11E
Ehrlich	41N	172W
Eichstadt	23S	78W
Eijkman	63S	142W
Eimmart	24N	65E
Einstein	17N	87W
Einthoven	5S	110E
Elger	35S	30W
Ellerman	26S	121W
Ellison	55N	108W
Elvey	9N	101W
Emden	63N	176W
Encke	5N	37W
Endymion	54N	57E
Engelhardt	5N	159W
Eötvös	36S	134E
Epigenes	67N	5W
Epimenides	41S	30W
Eratosthenes	15N	11W
Erro	6N	98E
Esnault-Pelterie	47N	142W
Espin	28N	109E
Euclides	7S	29W
Euctemon	76N	31E
Eudoxus	44N	16E
Euler	23N	29W
Evans	10S	134W
Evdokimov	35N	153W
Evershed	36N	160W
Fabricius	43S	42E
Fabry	43N	100E
Faraday	42S	9E

CRATERS

Fauth	6N	20W
Faye	21S	4E
Fechner	59S	125E
Fen'yi	45S	105W SJ
Feoktistov	31N	140E
Fermat	23S	20E
Fermi	20S	122E
Fernelius	38S	5E
Fersman	18N	126W
Feuillée	27N	9W
Firmicus	8N	64E
Firsov	4N	112E
~~Fitz-Gerard~~ Fitzgerald	27N	172W
Fizeau	58S	133W
Flammarion	3S	4W
Flamsteed	4S	44W
Fleming	15N	109E
Focas	34S	94W
Fontana	16S	57W
Fontenelle	63N	19W
Foster	23N	142W
Foucault	50N	40W
Fourier	30S	53W
Fowler	43N	145W
Fracastorius	21S	33E
Fra Mauro	6S	17W
Franklin	39N	48E
Franz	17N	40E
Fraunhofer	39S	59E
Freundlich	25N	171E
Fridman	13S	127W
Froelich	80N	110W
Frost	37N	119W
Furnerius	36S	60E SJ
Gadomski	36N	147W
Gagarin	20S	150E
Galilaei	11N	63W
Galle	56N	22E
Galois	14S	153W
Galvani	50N	84W
Gambart	1N	15W
Gamow	65N	144E
Gansky	10S	97E
Ganswindt	80S	110E
Garavito	48S	157E
Gärtner	59N	35E
Gassendi	17S	40W
Gaudibert	11S	38E
Gauricus	34S	13W
Gauss	36N	79E
Gavrilov	17N	131E

CRATERS

Gay-Lussac	14N	21W
Geber	19S	14E
Geiger	14S	158E
Geminus	35N	57E
Gemma Frisius	34S	13E
Gerard	45N	31W
Gerasimovič	23S	124W
Gernsback	36S	99E
Gibbs	18S	84E
Gilbert	3S	76E
Gill	64S	75E
Ginzel	14N	97E
Gioja	83N	2E
Giordano Bruno	36N	103E
Glaisher	13N	49E
Glasenap	2S	138E
Goclenius	10S	45E
Goddard	15N	89E
Godin	2N	10E
Goldschmidt	73N	3W
Golitsyn	25S	105W
Golovin	40N	161E
Goodacre	33S	14E
Gould	19S	17W
Grachev	3S	108W
Graff	43S	88W
Green	4N	133E
Gregory	2N	127E
Grigg	13N	130W
Grimaldi	5S	68W SJ
Grissom	47S	149W
Grotrian	66E	128E
Grove	40N	33E
Gruemberger	67S	12W SJ
Gruithuisen	33N	40W
Guericke	12S	14W
Gullstrand	45N	130W
Gum	40S	89E
Gutenberg	9S	41E
Guthnick	48S	94W
Guyot	11N	117E
Gyldén	5S	0
Hagecius	60S	47E
Hagen	48S	135E SJ
Hahn	31N	74E
Haidinger	39S	25W
Hainzel	41S	33W
Hale	74S	91E
Hall	34N	37E
Halley	8S	6E
Hamilton	43S	85E

CRATERS		
Hanno	56S	71E
Hansen	14N	73E
Hansteen	12S	52W
Harding	44N	71W
Harpalus	53N	43W
Harriot	33N	114E
Hartmann	3N	135E
Hartwig	6S	80W
Harvey	19N	147W
Hase	29S	63E
Hatanaka	29N	122W
Hausen	65S	89W
Hayford	13N	176W
Hayn	65N	84E
Healy	32N	111W
Heaviside	10S	167E
Hecataeus	22S	79E
Hedin	3N	77W
Heinsius	39S	18W
Heis	32N	32W
Helberg	22N	102W
Helicon	40N	23W
Hell	32S	8W
Helmholtz	68S	64E
Henderson	5N	152E
Hendrix	48S	161W
Henry, Paul	24S	57W
Henry, Prosper	24S	59W
Henyey	13N	152W
Heraclitus	49S	6E
Hercules	47N	39E
Herigonius	13S	34W
Hermann	1S	57W
Hermite	86N	86W
Herodotus	23N	50W
Herschel	6S	2W
C. Herschel	35N	31W
J. Herschel	62N	41W
Hertz	13N	104E
Hertzsprung	0	129W
Hesiodus	29S	16W
Hess	54S	174E
Hevelius	2N	67W
Heymans	75N	144W
Hilbert	18S	108E
Hind	8S	7E
Hippalus	25S	30W
Hipparchus	6S	5E
Hippocrates	71N	146W
Hirayama	6S	93E
Hoffmeister	15N	137E
Hogg	34N	122E

CRATERS		
Hohmann	18S	94W
Holden	19S	63E
Holetschek	28S	151E
Hommel	55S	33E
Hooke	41N	55E
Horrebow	59N	41W
Horrocks	4S	6E
Hortensius	6N	28W
Houzeau	18S	124W
Hubble	22N	87E
Huggins	41S	1W
Humboldt	27S	81E
Hutton	37N	169E
Hyginus	8N	6E
Hypatia	4S	23E
Ibn Yunus	14N	91E
Icarus	6S	173W
Ideler	49S	22E
Idelson	81S	114E
Ingalls	26N	153W
Inghirami	48S	69W
5J Innes	28N	119E
Isidorus	8S	33E
Izsak	23S	117E
Jackson	22N	163W
Jacobi	57S	11E
Jansen	14N	29E
Jansky	9N	90E
Janssen	45S	42E
Jeans	55S	91E
Jenner	42S	96E
Joffe	15S	129W
Joliot	26N	94E
Joule	27N	144W
Jules Verne	35S	147E
Julius Caesar	9N	15E
Kaiser	36S	7E
Kamerlingh Onnes	15N	116W
Kane	63N	26E
Kant	11S	20E
Kapteyn	11S	71E
Karpinsky	73N	166E
Kästner	7S	79E
Kearons	12S	113W
Keeler	10S	162E
Kekulé	16N	138W
Kepler	8N	38W
Khwolson	14S	112E
Kibal'chich	2N	147W
Kidinnu	36N	123E

CRATERS		
Kies	26S	23W
Kimura	57S	118E
Kinau	61S	15E
King	5N	120E
Kirch	39N	6W
Kircher	67S	45W 3J.
Kirchhoff	30N	39E
Kirkwood	69N	157W
Klaproth	70S	26W
Kleimenov	33S	141W
Klein	12S	3E
Klute	37N	142W
Koch	43S	150E
Kohlschütter	15N	154E
Kolhörster	10N	115W
Komarov	25N	153E
Kondratyuk	15S	115E
König	24S	25W
Konstantinov	20N	159E
Kopff	17S	90W
Korolev	5S	157W
Kostinsky	14N	118E
Kovalevskaya	31N	129W
Kovalsky	22S	101E
Krafft	17N	73W
Kramers	53N	128W
Krasnov	30S	80W
Krasovsky	4N	176W
Krieger	29N	46W
Krylov	35N	167W
Krusenstern	26S	6E
Kugler	53S	104E
Kulik	42N	155W
Kunowsky	3N	32W
Kuo Shou Ching	8N	134W
Kurchatov	38N	142E
La Caille	24S	1E
Lacchini	41N	107W
La Condamine	53N	28W
Lacroix	38S	59W
Lade	1S	10E
Lagalla	45S	23W
Lagrange	33S	72W
Lalande	4S	9W
Lamarck	23S	70W
Lamb	43S	101E
Lambert	26N	21W
Lamé	15S	64E
Lamèch	43N	13E
Lamont	5N	23E
Lampland	31S	131E
Landau	42N	119W

CRATERS

Lane	9S	132E
Langemak	10S	119E
Langevin	44N	162E
Langley	51N	86W
Langmuir	36S	129W
Langrenus	9S	61E
Lansberg	0	27W
La Pérouse	11S	77E
Larmor	32N	180
Lassell	15S	8W
Laue	28N	97W
Lauritsen	27S	96E
Lavoisier	38N	81W
Leavitt	46S	140W
Lebedev	48S	108E
Lebedinsky	8N	165W
Lee	31S	41W
Leeuwenhoek	30S	179W
Legendre	29S	70E
~~Legentil~~ Le Gentil	74S	76W
Lehmann	40S	56W
Leibnitz	38S	178E
Lemaitre	62S	150W
Le Monnier	26N	31E
Lenz	3N	102W
Leonev	19N	148E
Lepaute	33S	34W
Letronne	11S	42W
Leucippus	29N	116W
Leuschner	1N	109W
Le Verrier	40N	21W
Levi-Civita	24S	143E
Lewis	19S	114W
Lexell	36S	4W
Ley	43N	154E
Liapunov	27N	90E
Licetus	47S	7E
Lichtenberg	32N	68W
Lick	12N	53E
Liebig	24S	48W
Lilius	54S	6E
Lindblad	70N	99W
Lindenau	32S	25E
Linné	28N	12E
Lippershey	26S	10W
Littrow	21N	31E
Lobachevsky	10N	113E
Lockyer	47S	37E
Lodygin	18S	147W
Loewy	23S	33W
Lohrmann	0	67W
Lohse	14S	60E
Lomonosov	27N	98E
Longomontanus	50S	22W
Lorentz	34N	100W
Louville	44N	45W
Love	6S	129E
Lovelace	82N	107W
Lovell	37S	143W
Lowell	13S	103W
Lubbock	4S	42E
Lubiniezky	18S	24W
Lucretius	9S	121W
Lundmark	39S	152E
Luther	33N	24E
Lütke	17S	123E
Lyell	14N	41E
Lyman	65S	162E
Lyot	50S	84E
Mach	18N	149W
Maclaurin	2S	68E
Maclear	10N	20E
Macrobius	21N	46E
Mädler	11S	30E
Maestlin	5N	41W
Magelhaens	12S	44E
Maginus	50S	6W
Main	81N	10E
Mairan	42N	43W
Maksutov	41S	169W
Malapert	85S	13E SJ
Mallet	46S	54E
Malyi	22N	105E
Mandel'shtam	6N	162E
Manilius	14N	9E
Manners	5N	20E
Manzinus	68S	27E
Maraldi	19N	35E
Marci	22N	169W
Marconi	9S	145E
Marco Polo	15N	2W
Marinus	39S	76E
Mariotte	29S	140W
Marius	12N	51W
Markov	53N	63W
Marth	31S	29W
Maskelyne	2N	30E
Mason	43N	30E
Maunder	14S	94W
Maupertuis	50N	27W
Maurolycus	42S	14E
Maury	37N	40E
Maxwell	30N	99E
C. Mayer	63N	17E SJ
T. Mayer	16N	29W
McClure	15S	50E
McKellar	16S	171W
McLaughlin	47N	93W
McMath	15N	167W
McNally	22N	127W SJ
Mee	44S	35W
Mees	14N	96W
Meggers	24N	123E
Meitner	11S	113E
Mendel	49S	110W
Mendeleev	6N	141E
Menelaus	16N	16E
Mercator	29S	26W
Mercurius	47N	66E
Mersenius	21S	49W
Merrill	75N	116W
Mesentsev	72N	129W
Meshchersky	12N	125E
Messala	39N	60E
Messier	2S	48E
Metchnikov	11S	149W
Metius	40S	43E
Meton	74N	19E
Michelson	6N	121W
Milankovič	77N	169E
Milichius	10N	30W
Miller	39S	1E
Millikan	47N	121E
Mills	9N	156E
Milne	31S	113E
Mineur	25N	162W
Minkowski	56S	145W
Minnaert (Provisional)	67S	179E
Mitchell	50N	20E
Mitra	18N	155W
Möbius	16N	101E
Mohorovičić	19S	165W
Moigno	66N	29E
Moiseev	9N	103E
Moltke	1S	24E
Monge	19S	48E
Montanari	46S	21W
Montgolfier	47N	160W
Moore	37N	178W
Moretus	71S	6W SJ
Morozov	5N	127E
Morse	22N	175W
Moseley	21N	90W
Mösting	1S	6W
Mouchez	78N	27W
Moulton	61S	97E
Müller	8S	2E
Murchison	5N	0
Mutus	64S	30E

CRATERS		
Nagaoka	20N	154E
Nassau	25S	177E
Nansen	81N	95E
Nasireddin	41S	0
Nasmyth	50S	56W
Naumann	35N	62W
Neander	31S	40E
Nearch	58S	39E
Neison	68N	25E
Neper	9N	85E
Nernst	36N	95W
Neujmin	27S	125E
Neumayer	71S	70E
Newcomb	30N	44E
Newton	77S	17W
Nicholson	26S	85W
Nicolai	42S	26E
Nícollet	22S	12W
Niepce	72N	120W
Nijland	33N	134E
Nikolaev	35N	151E
Nishina	45S	171W
Nobel	15N	101W
Nöggerath	49S	46W
Nonius	35S	4E
Nöther	66N	114W
Numerov	71S	161W
Nušl	32N	167E
Obruchev	39S	162E
O'Day	31S	157E
Oenopides	57N	64W
Oersted	43N	47E
Ohm	18N	114W
Oken	44S	76E
Olbers	7N	76W
Olcott	20N	118E
Omar Khayyam	58N	102W
Opelt	16S	17W
Oppenheimer	35S	166W
Oppolzer	2S	0
Oresme	43S	169E
Orlov	26S	175W
Orontius	40S	4W
Ostwald	11N	122E
Palisa	9S	7W
Palitzsch	28S	64E
Pallas	6N	2W
Palmieri	29S	48W SJ
Paneth	63N	95W
Pannekoek	4S	140E
Papaleski	10N	164E

CRATERS		
Paracelsus	23S	163E
Paraskevopoulos	50N	150W
Parenago	26N	109W
Parkhurst	34S	103E
Parrot	15S	3E
Parry	8S	16W
Parsons	37N	171W
Pascal	74N	70W
Paschen	14S	141W
Pasteur	12S	105E
Pauli	45S	137E
Pavlov	29S	142E
Pawsey	44N	145E
Peary	30E	89N
Pease	13N	106W
Peirce	18N	53E
Peirescius	46S	68E
Pentland	65S	11E
Perelman	24S	106E
Perepelkin	10S	128E
Perkin	47N	176W
Perrine	42N	129W
Petavius	25S	60E
Petermann	74N	67E
Peters	68N	29E
Petrie	45N	108E
Petropavlovsky	37N	115W
Petrov	61S	88E
Pettit	28S	86W
Petzval	63S	113W
Phillips	27S	76E
Philolaus	72N	33W
Phocylides	53S	57W
Piazzi	37S	68W
Piazzi Smyth	42N	3W
Picard	15N	55E
Piccolomini	30S	32E
Pickering	3S	7E
Pictet	44S	7W
Pingré	58S	74W
Pirquet	20S	140E
Pitatus	30S	14W
Pitiscus	51S	31E
Pizzetti	35S	119E
Plana	42N	28E
Planck	58S	135E
Plaskett	82N	175E
Plato	51N	9W
Playfair	23S	8E
Plinius	15N	24E
Plummer	25S	155W
Plutarch	24N	79E
Pogson	42S	111E

CRATERS		
Poincaré	57S	161E
Poinsot	79N	145W
Poisson	30S	11E
Polybius	22S	26E
Polzunov	26N	115E
Poncelet	76N	54W
Pons	25S	22E
Pontanus	28S	14E
Pontécoulant	59S	66E
Popov	17N	99E
Porter	56S	10W
Posidonius	32N	30E
Poynting	17N	133W
Prager	4S	131E
Prandtl	60S	141E
Priestley	57S	108E
Prinz	26N	44W
Proclus	16N	47E
Proctor	46S	5W
Protagoras	56N	7E
Ptolemaeus	9S	2W
Puiseux	28S	39W
SJ Purbach	26S	2W
Purkyně	1S	95E
Pythagoras	63N	62W
Pytheas	21N	21W
Quételet	43N	135W
Rabbi Levi	35S	24E
Racah	14S	180
Raimond	14N	159W
Ramsay	40S	145E
Ramsden	33S	32W
Rasumov	39N	114W
Rayet	45N	114E
Rayleigh	29N	90E
Réaumur	2S	1E
Regiomontanus	29S	1W
Regnault	54N	88W
Reichenbach	30S	48E
Reimarus	48S	60E
Reiner	7N	55W
Reinhold	3N	23W
Repsold	52N	78W
Rhaeticus	0	5E
Rheita	37S	47E
Riccioli	3S	74W SJ
Riccius	37S	26E SJ
Ricco	75N	177E
Riedel	49S	140W
Riemann	40N	88E
Ritchey	11S	8E

CRATERS		
Rittenhouse	74S	107E
Ritter	2N	19E
Ritz	15S	92E
Roberts	71N	174W
Robertson	22N	105W
Robinson	59N	46W
Rocca	13S	73W
Roche	42S	135E
Römer	25N	36E
Röntgen	33N	92W
Rosenberger	55S	43E
Ross	12N	22E
Rosse	18S	35E
Rost	56S	34W
Rothmann	31S	28E
Rowland	57N	163W
Rozhdestvensky	86N	155W
Rumford	29S	170W
Russell	27S	75W
Rutherfurd	61S	12W
Rydberg	47S	96W
Rynin	47N	104W
Sabine	1N	20E
Sacrobosco	24S	17E
Saenger	4N	102E
Šafařík	10N	177E
Saha	2S	103E
St. John	10N	150E
Sanford	32N	139W
Santbech	21S	44E
Sarton	49N	121W
Sasserides	39S	10W
Saunder	4S	9E
Saussure	43S	4W
Scaliger	27S	109E
Schaeberle	26S	117E
Scheiner	60S	28W
Schiaparelli	23N	59W
Schickard	45S	55W
Schiller	52S	40W
Schjellerup	69N	157E
Schlesinger	47N	138W
Schliemann	2S	155E
Schlüter	6S	83W
Schmidt	1N	19E
Schneller	42N	164W
Schomberger	77S	25E
Schönfeld	45N	98W
Schorr	19S	90E
Schrödinger	75S	133E
Schröter	3N	7W
Schubert	3N	81E
Schumacher	43N	61E
Schuster	4N	147E

CRATERS		
Schwabe	65N	45E
Schwartzschild	71N	120E
Scoresby	78N	14E
Scott	82S	45E
Seares	74N	145E
Secchi	2N	43E
Sechenov	7S	143W
Seeliger	2S	3E
Segers	47N	128E
Segner	59S	48W
Seidel	33S	152E
Seleucus	21N	67W
Seneca	27N	80E
Seyfert	29N	114E
Shajn	33N	172E
Shaler	33S	85W
Sharonov	13N	173E
Sharp	46N	40W
Shatalov	24N	140E
Sheepshanks	59N	17E
Shi Shen	76N	104E
Short	75S	8W
Shternberg	19N	117W
Shuckburgh	43N	53E
Siedentopf	22N	135E
Sierpinski	27S	155E
Silberschlag	6N	13E
Simpelius	73S	15E
Sinas	9N	32E
Sirsalis	12S	60W
Sisakyan	41N	109E
Sklodowska	18S	96E
Slipher	50N	160E
Smoluchowski	60N	96W
Snellius	29S	56E
Sniadecki	22S	169W
Sommerfeld	65N	161W
Sömmering	0	8W
Sosigenes	9N	18E
South	57N	51W
Spallanzani	46S	24E
Spencer Jones	13N	166E
Spiru Haret	59S	176W
Spörer	4S	2W
Stadius	10N	14W
Stark	25S	134E
Stebbins	65N	143W
Stefan	46N	109W
Stein	7N	179E
Steinheil	49S	47E
Steklov	37S	105W
Steno	33N	162E
Stetson	40S	119W
Stevinus	33S	54E
Stiborius	34S	32E

CRATERS		
Stöfler	41S	6E
Stokes	53N	89W
Stoletov	45N	155W
Stoney	56S	156W
Störmer	57N	145E
Strabo	62N	54E
Stratton	6S	165E
Street	47S	11W
Strömgren	22S	133W
Struve	23N	76W
Subbotin	29S	135E
Suess	4N	48W
Sulpicius Gallus	20N	12E
Sumner	37N	109E
Sundman	11N	91W
Swann	52N	112E
Sylvester	83N	82W
Szilard	34N	106E
Tacitus	16S	19E
Tacquet	17N	19E
Tannerus	56S	22E
Taruntius	6N	46E
Taylor	5S	17E
Teisserenc	32N	136W
Tempel	4N	12E
Tereshkova	28N	144E
Tesla	38N	125E
Thales	62N	50E
Theaetetus	36N	6E
Thebit	22S	4W
Theon Junior	2S	16E
Theon Senior	1S	15E
Theophilus	11S	26E
Thiel	40N	134W
Thiessen	75N	169W
Thomson	33S	166E
Tihomirov	25N	162E
Tikhov	62N	172E
Tiling	52S	132W
Timaeus	63N	1W
Timiryazev	5S	147W
Timocharis	27N	13W
Tisserand	21N	48E
Titius	27S	101E
Titov	29N	150E
Torricelli	5S	28E
Tralles	28N	53E
Triesnecker	4N	4E
Trouvelot	49N	6E
Trumpler	28N	168E
Tsander	5N	149W
Tsiolkovsky	20S	129E
Tsu Chung-Chi	17N	144E

CRATERS

Turner	1S	13W
Tycho	43S	11W
Tyndall	35S	117E
Ukert	8N	1E
Ulugh Beigh	33N	82W
Valier	7N	174E
Van de Graaff	27S	172E
Van den Bergh	31N	159W
Van der Waals	44S	119E
Van Gent	16N	160E
Van Maanen	36N	127E
Van Rhijn	52N	145E
Van't Hoff	62N	133W
Van Wijk	63S	119E
Vasco da Gama	14N	84W
Vashakidze	44N	93E
Vavilov	1S	139W
Vega	45S	63E
Vendelinus	16S	62E
Vening Meinesz	0	163E
Ventris	5S	158E
Vernadsky	23N	130E
Vesalius	3S	115E
Vestine	34N	94E
Vetchinkin	10N	131E
Vieta	29S	56W
Vil'ev	6S	144E
Vitello	30S	37W
Vitruvius	18N	31E
Vlacq	53S	39E
Vogel	15S	6E
Volta	54N	85W
Volterra	57N	131E
Von der Pahlen	25S	133W
Von Kármán	45S	176E
Von Neumann	40N	153E
Von Zeipel	42N	142W
Voskresensky	28N	88W
Walker	26S	162W
Wallace	20N	9W
Walter	33S	1E
Wan-Hoo	11S	139W
Wargentin	49S	60W
Waterman	26S	128E
Watson	63S	124W
Watt	50S	49E
Webb	1S	60E
Weber	50N	124W
Wegener	45N	114W
Weigel	58S	39W
Weinek	27S	37E
Weiss	32S	20W

CRATERS

Wells	41N	122E
Werner	28S	3E
Wexler	69S	90E
Weyl	16N	120W
Whewell	4N	14E
White	45S	160W
Wichmann	8S	38W
Wiechert	84S	165E
Wiener	41N	146E
Wilhelm	43S	21W
Wilkins	29S	20E
Williams	42N	37E
Wilsing	22S	155W
Wilson	69S	42W
Winkler	42N	179W
Winlock	35N	106W
Wöhler	38S	31E
Wolf	23S	17W
Wollaston	31N	47W
Woltjer	45N	160W
Wood	44N	121W
Wright	32S	86W
Wrottesley	24S	57E
Wurzelbauer	34S	16W
Wyld	1S	98E
Xenophanes	58N	82W
Yablochkov	61N	127E
Yamamoto	59N	161E
Yerkes	15N	52E
Young	41S	51E
Zach	61S	5E
Zagut	32S	22E
Zeeman	75S	135W
Zelinsky	29S	167E
Zeno	45N	73E
Zernike	18N	168E
Zhiritsky	25S	120E
Zhukovsky	7N	167W
Zinger	57N	176E
Zöllner	8S	19E
Zsigmondy	59N	105W
Zuchius	61S	50W 5J
Zupus	17S	52W 5J

SEAS (Maria)

Mare Anguis (Serpent Sea)	22N	65E
Mare Australe (Southern Sea)	50S	95E
Mare Cognitum (Known Sea)	10S	23W
Mare Crisium (Sea of Crises)	16N	59E
Mare Fecunditatis (Sea of Fertility)	6S	51E
Mare Frigoris (Sea of Cold)	55N	6E
Mare Humboldtianum (Humboldt's Sea)	56N	82E
Mare Humorum (Sea of Moisture)	24S	38W
Mare Imbrium (Sea of Rains)	35N	15W
Mare Ingenii (Sea of Ingenuity)	34S	164E
Mare Marginis (Border Sea)	12N	88E
Mare Moscoviense (Moscow Sea)	28N	143E
Mare Nectaris (Sea of Nectar)	15S	35E
Mare Nubium (Sea of Clouds)	22S	15W
Mare Orientale (Eastern Sea)	20S	95W
Oceanus Procellarum (Ocean of Storms)	20N	60W
Mare Serenitatis (Sea of Serenity)	27N	18E
Mare Smythii (Smyth's Sea)	1N	86E
Mare Spumans (Foaming Sea)	1N	66E
Mare Tranquillitatis (Sea of Tranquillity)	10N	31E
Mare Undarum (Sea of Waves)	7N	69E
Mare Vaporum (Sea of Vapours)	14N	3E

BAYS (Sinus)

Sinus Aestuum (Seething Bay)	11N	8W
Sinus Iridum (Bay of Rainbows)	44N	31W
Sinus Lunicus (See Commemorative Features)	32N	2W
Sinus Medii (Central Bay)	1N	0
Sinus Roris (Bay of Dew)	52N	50W

LAKES (Lacus)

Lacus Aestatis (Lake of Summer)	15S	69W
Lacus Autumni (Lake of Autumn)	12S	84W
Lacus Mortis (Lake of Death)	45N	27E
Lacus Somniorum (Lake of Dreams)	38N	31E
Lacus Veris (Lake of Spring).	17S	86W

MARSHES (Paludes)

Palus Epidemiarum (Marsh of Diseases)	32S	28W
Palus Putredinus (Marsh of Decay)	28N	0
Palus Somni (Marsh of Sleep)	16N	44E

MOUNTAINS (Montes)

Montes Alpes (Alps)	48N	0
Montes Apenninus (Apennines)	20N	1W
Montes Carpatus (Carpathians)	15N	24W
Montes Caucasus (Caucasus Mts.)	37N	9E
Montes Cordillera (Cordilleras)	5-35S	79-112W
Montes Haemus (Haemus Mts.)	18N	13E
Montes Harbinger (Harbinger Mts.)	27N	42W
Montes Jura (Jura Mts.)	48N	32W
Montes Pyrenaeus (Pyrénées)	15S	41E
Montes Recti (Straight Range)	49N	20W
Montes Riphaeus (Riphaean Mts.)	7S	28W
Montes Rook (Rook Mts.)	10-30S	82-105W
Montes Spitzbergensis (Spitzbergen Mts.)	35N	5W
Montes Taurus (Taurus Mts.)	28N	42E
Montes Teneriffe (Tenerife Mts.)	48N	13W

CAPES (Promontoria)

Pr. Archerusia	17N	21E
Pr. Agarum	14N	66E
Pr. Agassiz	42N	2E
Pr. Banat	17N	26W
Pr. Deville	44N	1E
Pr. Fresnel	29N	5E
Pr. Heraclides	41N	34W
Pr. Kelvin	27S	33W
Pr. Laplace	26N	25W
Pr. Lavinium	15N	49E
Pr. Olivium	16N	49E
Pr. Taenarium	19S	7W

PEAKS (Mons)

Mons Ampère	19N	4W
Mons Argaeus	19N	29E
Mont Blanc	46N	0
Mons Bradley	22N	1E
Mons Hadley	27N	5E
Mons Huygens	20N	2W
Mons La Hire	28N	25W
Mons Pico	46N	9W
Mons Piton	41N	1W
Mons Rümker	41N	58W
Mons Serao	17N	6W
Mons Wolff	17N	7W

RILLES/CLEFTS (Rimae)

Rima Agatharchides I	20S	28W
Rima Alphonsus I, II	14S	2W
Rima Archimedes I, II, III, IV, V, VI	27N	6W
Rima Archytas I	55N	2E
Rima Ariadaeus, I	6N	14E
Rima Aristarchus I, II, III, IV, V, VI, VII, VIII	27N	47E
Rima Aristoteles I, II	54N	15E
Rima Arzachel I, II	9S	1W
Rima Atlas I, II, III, IV, V	47N	45E
Rima Billy I, II	14S	49W
Rima Birt I	22S	9W
Rima Bode I, II, III, IV, V	10N	4W
Rima G. Bond I	33N	35E
Rima Boscovich I, II	10N	11E
Rima Bradley	25N	0
Rima Burckhardt I	32N	58E
Rima Bürg I, II	44N	24E
Rima Calippus I	37N	13E
Rima Cardanus	12N	72W
Rima Cauchy I	11N	38E

RILLES/CLEFTS (Rimae)

Rima Cavendish I, II	25S	52W
Rima Chacornac I, II, III, IV	29S	32E
Rima Cleomedes I	28N	56E
Rima Conon	19N	2E
Rima Daniell I, III, IV	38N	24E
Rima Darwin I, II, III, IV	20S	66W
Rima Davy I	11S	6W
Rima de Gasparis I, II, III, IV	26S	51W
Rima Doppelmayer I, II, III	27S	44W
Rima Eudoxus I, II	43N	13E
Rima Flammarion	2S	5W
Rima Fresnel I, II, III	29N	5E
Rima Furnerius I	35S	61E
Rima Gärtner I	60N	37E
Rima Gassendi I, II, III, IV, V, VI, VII, VIII, IX	17S	39W
Rima Gay-Lussac I, II	13N	22W
Rima Goclenius I, II	8S	42E
Rima Gould I	21S	19W
Rima Grimaldi I, II, III, IV	5S	64W
Rima Guericke I	16S	15W
Rima Gutenberg I, II, III, IV, V	6S	39E
Rima Hadley	26N	3E
Rima Hansteen I	12S	52W
Rima Hedin I	3N	73W
Rima Herigonius I	14S	37W
Rima Hesiodus	30S	22W
Rima Hevelius I, II, III	2N	67W
Rima Hippalus I, II, III, IV, V	25S	29W
Rima Hyginus, I	8N	7E
Rima Hypatia I, II	0	23E
Rima Jansen I	15N	30E
Rima Janssen I	45S	39E
Rima Krafft	15N	72W
Rima La Hire I, II	28N	27W
Rima Lassell I	16S	10W
Rima Letronne I	12S	40W
Rima Littrow I, II, III, IV, V, VI, VII	22N	31E
Rima Lohrmann I, II, III	0	65W
Rima Maclear I, II	13N	20E
Rima Marius	17N	49W
Rima Menelaus I, II, III	17N	17E

RILLES/CLEFTS (Rimae)

Rima Mersenius I, II, III	20S	46W
Rima Messier I	1S	44E
Rima Newcomb I	31N	41E
Rima Opelt I	13S	18W
Rima Oppolzer I	1S	2E
Rima Palmieri I	28S	47W
Rima Parry I, II, III, IV, V, VI	8S	17W
Rima Petavius I, II, III	26S	59E
Rima Pitatus I, II, III	30S	12W
Rima Plato I, II, III	52N	4W
Rima Plinius I, II, III	17N	24E
Rima Posidonius I, II, III, IV, V, VI	32N	30E
Rima Prinz I, II	27N	44W
Rima Ptolemaeus I	10S	3W
Rima Ramsden I, II, III, IV, V, VI	33S	31W
Rima Réaumur	3S	3E
Rima Rhaeticus I	0	4E
Rima Riccioli I, II	0	75W
Rima Ritter I, II, III, IV, V	3N	20E
Rima Römer I, II	27N	35E
Rima Schröter I	1N	6W
Rima Sharp I	46N	51W
Rima Sirsalis, I, II, III, IV, V	16S	61W
Rima Sosigenes I, II III, IV	7N	19E
Rima Stadius I, II	15N	17W
Rima Sulpicius Gallus I, II, III	21N	10E
Rima Theaetetus I, II, III	33N	6E
Rima Triesnecker I, II, III, V, VI, VII	4N	5E
Rima Zupus I, II	15S	53W

SCARPS (Rupes)

Rupes Altai (Altai Scarp)	25S	23E
Rupes Cauchy (Cauchy Scarp)	9N	38E
Rupes Kelvin (Kelvin Scarp)	28S	33W
Rupes Liebig (Liebig Scarp)	27S	45W

SCARPS (Rupes)

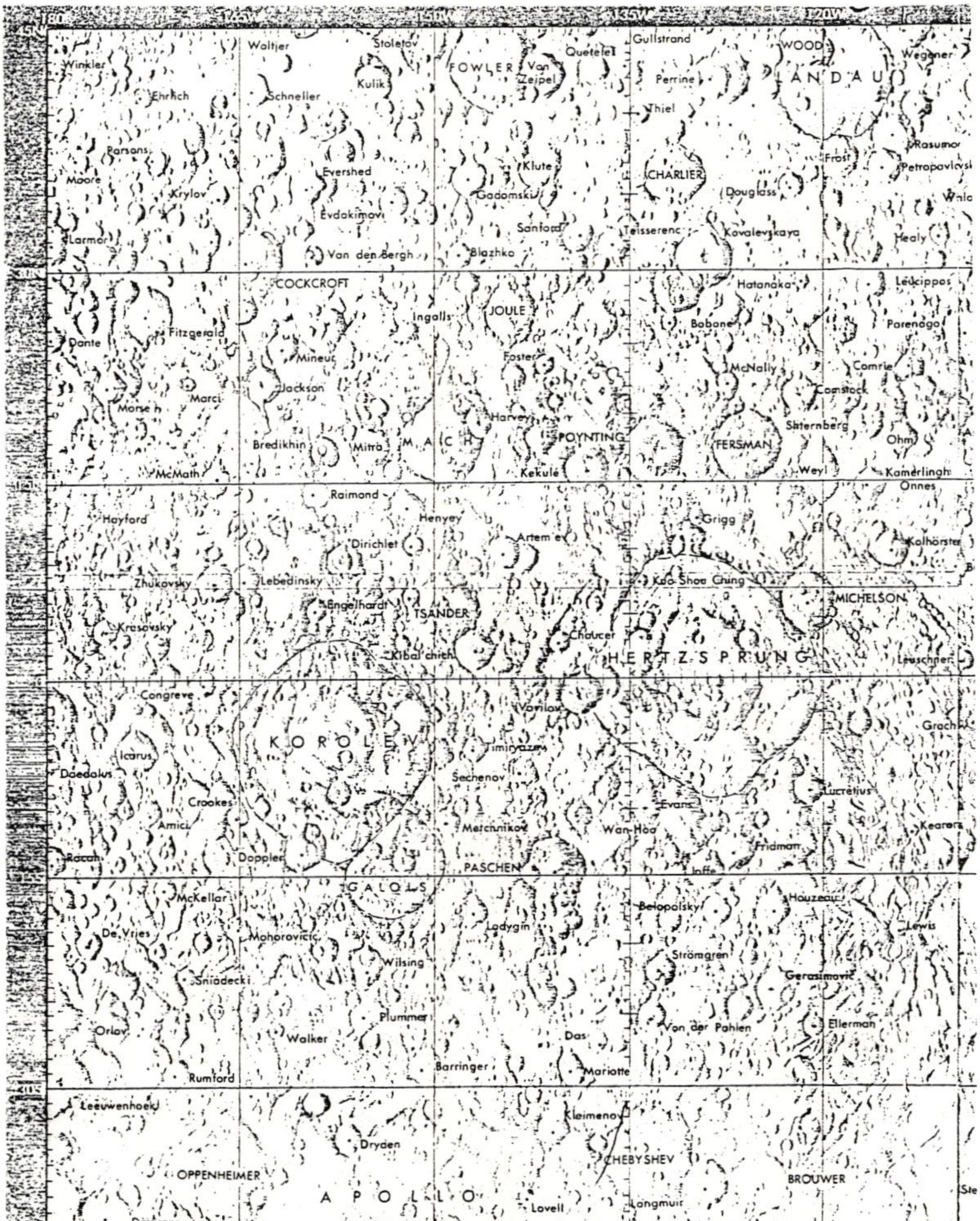
Rupes Mercator (Mercator Scarp)	30S	23W
Rupes Recta (Straight Wall)	22S	7W

VALLEYS (Vallis)

Vallis Alpes (Alpine Valley)	49N	3E
Vallis Baade	47S	77W
Vallis Bouvard	39S	83W
Vallis Inghirami	44S	72W
Vallis Palitzsch	24S	64E
Vallis Planck	59S	126E
Vallis Rheita (Rheita Valley)	44S	52E
Vallis Schrödinger	67S	105E
Vallis Schröteri (Schröter's Valley)	26N	51W
Vallis Snellius	30S	53E

COMMEMORATIVE FEATURES
(Marked with an "X")

Planitia Descensus (Site of 1st USSR Soft Landing)	7N	64W
Sinus Lunicus (Site of 1st USSR Hard Landing)	32N	2W
Statio Tranquillitatis (Site of 1st USA Manned Landing)	1N	24E


180
165W
150W
135W
120W
Winkler
Woltjer
Stoletov
FOWLER
Van Zeipel
Quetelet
Gullstrand
WOOD
Wegener
Ehrlich
Schneller
Kulik
Perrine
LANDAU
Thiel
Parsons
Moore
Krylov
Evershed
Klute
CHARLIER
Frost
Rasumov
Petropavlovsk
Gadomski
Douglass
Evdokimov
Sanford
Teisserenc
Kovalevskaya
Healy
Larmor
Van den Bergh
Blazhko
COCKCROFT
Hatanaka
Leucippus
Ingalls
JOULE
Babcock
Parenago
Dante
Fitzgerald
Mineur
Foster
McNally
Comrie
Jackson
Comstock
Morse
Marci
Harvey
Sternberg
Bredikhin
Mitra
MACH
POYNTING
FERSMAN
Ohm
McMath
Kekulé
Weyl
Kamerlingh Onnes
Raimond
Hayford
Henyey
Grigg
Dirichlet
Artem'ev
Kolhörster
Zhukovsky
Lebedinsky
Kuo Shou Ching
Engelhardt
TSANDER
MICHELSON
Krasovsky
Chaucer
Kibal'chich
HERTZSPRUNG
Leuschner
Congreve
Vavilov
Grachev
Icarus
KOROLEV
Timiryazev
Daedalus
Sechenov
Lucretius
Crookes
Evans
Amici
Metchnikov
Wan-Hoo
Kearons
Racah
Doppler
PASCHEN
Fridman
Ioffe
GALOIS
McKellar
Belopolsky
Houzeau
De Vries
Mohorovičić
Ladygin
Lewis
Wilsing
Strömgren
Sniadecki
Gerasimovič
Plummer
Orlov
Walker
Das
Von der Pahlen
Ellerman
Barringer
Rumford
Mariotte
Leeuwenhoek
Kleimenov
Dryden
CHEBYSHEV
OPPENHEIMER
BROUWER
APOLLO
Lovell
Langmuir
Davisson
Borman
Chaffee
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Maksutov
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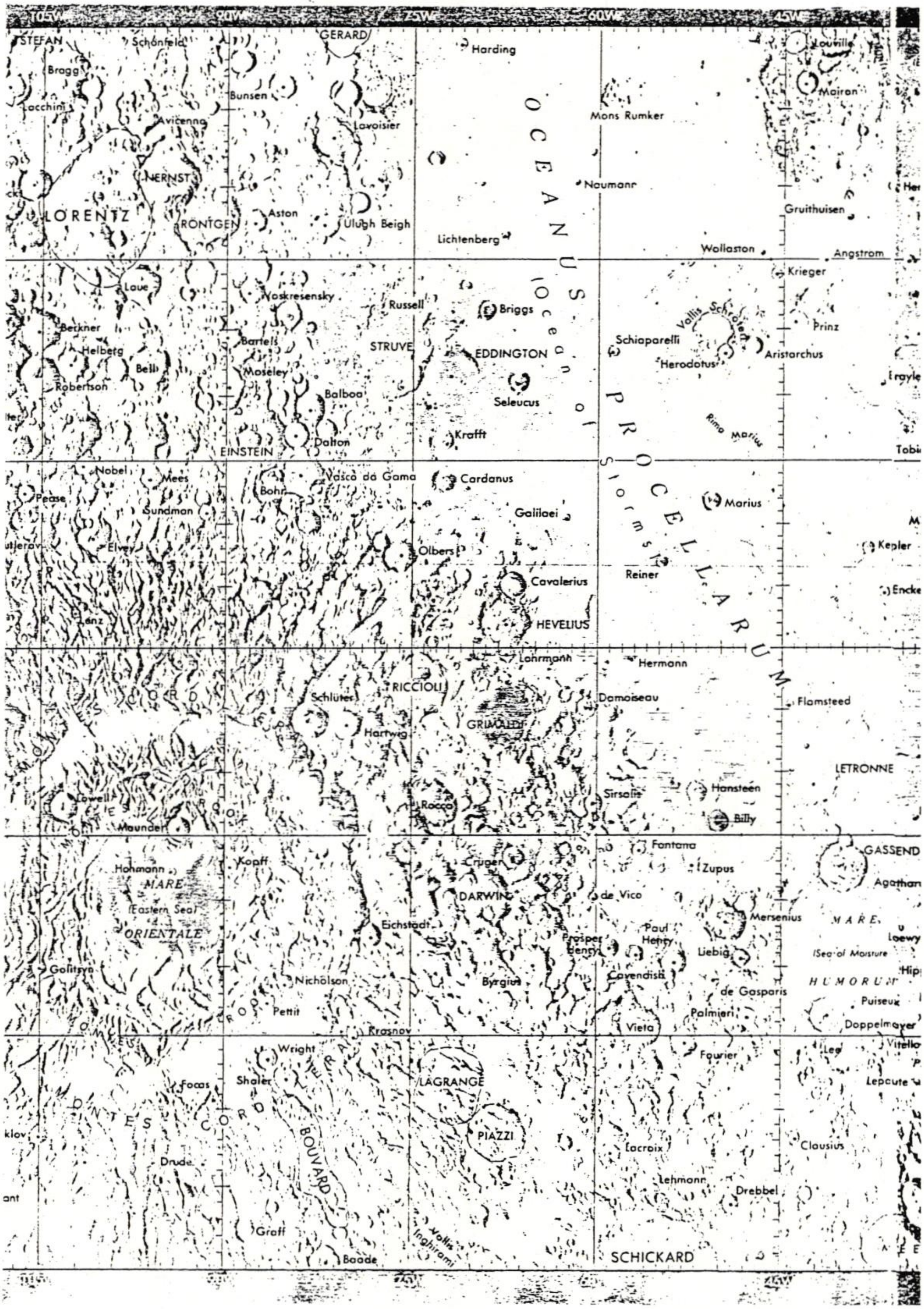
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Schönfeld
GERARD
Harding
Louville
Bragg
Bunsen
Mairan
Avicenna
Lavoisier
Mons Rumker
OCEANUS PROCELLARUM
(Ocean of Storms)
NERNST
Naumann
Gruithuisen
LORENTZ
RONTGEN
Aston
Ulugh Beigh
Lichtenberg
Wollaston
Angstrom
Laue
Voskresensky
Krieger
Russell
Briggs
Vallis Schröteri
Prinz
Berkner
Bartels
Schiaparelli
Helberg
STRUVE
EDDINGTON
Aristarchus
Bell
Moseley
Herodotus
Robertson
Balboa
Seleucus
Rima Marius
Krafft
EINSTEIN
Dalton
Tobi
Nobel
Mees
Vasco da Gama
Cardanus
Pease
Bohr
Sundman
Galilaei
Marius
Elvey
Olbers
Kepler
Reiner
Cavalerius
Encke
HEVELIUS
Lohrmann
Hermann
RICCIOLI
Schlüter
Damoiseau
Flamsteed
Hartwig
GRIMALDI
LETRONNE
Lowell
Sirsalis
Hansteen
Rocca
Billy
Maunder
Fontana
GASSEND
Hohmann
Kopff
Crüger
Zupus
MARE
(Eastern Sea)
ORIENTALE
DARWIN
de Vico
Agatharc
Eichstädt
Mersenius
MARE
Paul Henry
Loewy
Prosper Henry
Liebig
(Sea of Moisture
Golitsyn
Nicholson
Byrgius
Cavendish
HUMORUM
de Gasparis
Pettit
Puiseux
Krasnov
Palmieri
Vieta
Doppelmayer
Wright
Fourier
Vitello
Lee
Focas
Shaler
LAGRANGE
Lepaute
MONTES CORDILLERA
BOUVARD
PIAZZI
Lacroix
Clausius
Drude
Lehmann
Drebbel
Graff
Vallis Inghirami
Baade
SCHICKARD

30W
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15E
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Piazzi Smyth
Helicon
Le Verrier
Kirch
Cassini
Lamech
Eudoxus
Burg
LACUS MORTIS
Plana
William
Grove
Alexander
Calippus
LACUS SOMNIORUM
(Lake of Dreams)
Theaetetus
M A R E
(Sea of Rains)
Carlini
Aristillus
Daniell
Hall
G. Bond
I M B R I U M
Archimedes
Autolycus
M A R E
POSIDONIUS
Delisle
Chacornac
Diophantus
Timocharis
PALUS PUTREDINIS
Linné
(Sea of Serenity)
Le Monnier
Lambert
Römer
Euler
S E R E N I T A T I S
Conon
Bessel
Littrow
Wallace
Sulpicius Gallus
Pytheas
Maraldi
Dawes
Vitruvius
Menelaus
Marco Polo
M A R E
Plinius
Franz
CARPATUS
Eratosthenes
(Sea of Vapors)
Manilius
Auwers
Jansen
Lyell
Gay-Lussac
SINUS
V A P O R U M
Ross
(Seething Bay)
Stadius
COPERNICUS
AESTUUM
Boscovich
Julius Caesar
Maclear
M A R E
Sinas
Cauchy
Tichius
Sosigenes
Ukert
Hyginus
Rima Hyginus
Rima Ariadaeus
Arago
Lamont
Bode
Murchison
(Sea of Tranquility)
Pallas
Triesnecker
Tempel
Manners
T R A N Q U I L L I T A T I S
Fauth
Agrippa
Dionysius
Maskelyne
Reinhold
Schröter
Chladni
Godin
d'Arrest
Ritter
Kunowsky
Gambart
Sömmering
Schmidt
Sabine
Lansberg
Mösting
Oppolzer
Rhaeticus
Theon Senior
Theon Junior
Delambre
Rima Hypatia
Censorinus
Flammarion
Réaumur
Hypatia
Fra Mauro
Lalande
Spörer
Horrocks
Saunder
Taylor
Torricelli
Herschel
Gyldén
HIPPARCHUS
Alfraganus
MARE
Parry
PTOLEMAEUS
Zöllner
Isidorus
Capella
Euclides
Bonpland
(Known Sea)
Palisa
Müller
Halley
Andel
Theophilus
Mädler
COGNITUM
Guericke
Ritchey
Kant
Davy
Klein
Descartes
Lagrange
ALPHONSUS
ALBATEGNIUS
Cyrillus
M A R E
(Sea of Nectar)
Darney
Burnham
Abulfeda
Opelt
Lassell
Parrot
Vogel
Tacitus
Beaumont
N E C T A R I S
Alpetragius
Argelander
Almanon
Rosse
Lubiniezky
Arzachel
Airy
Geber
Gould
M A R E
Catharina
Bullialdus
Nicollet
Donati
Faye
Thebit
Abenezra
Azophi
Polybius
Wolf
Birt
Delaunay
Rupes Recta
Rupes Altai
FRACASTORIUS
König
La Caille
Playfair
Fermat
(Sea of Clouds)
Blanchinus
Sacrobosco
PURBACH
Krusenstern
Fox
Kies
N U B I U M
Apianus
Campanus
Weinek
Hesiodus
REGIOMONTANUS
Pontanus
Mercator
Werner
Wilkins
Dunthorne
PITATUS
Piccolomini
Poisson
Rothmann
Marth
Aliacensis
EPIDEMIARUM
Weiss
DESLANDRES
Gaudacre
Zagut
Lindenau
Ramsden
Hell
WALTER
Capuanus
Cichus
Gemma Frisius
Stiborius
Nonius
Wurzelbauer
Ball
Rabbi Levi
Gauricus
Elger
Lexell
Kaiser
Riccius
Sasserides
Fernelius
Heinsius
Wohle
Hainzel
Miller
Buch
BRENNER
Epimenides
ORONTIUS
STÖFLER
Faraday
MAUROLYCUS
Hainzel
Pictet
Huggins
Nasireddin
Nicolai
Lagalla
WILHELM
TYCHO
Saussure
FABRICIUS
BAROCIUS
JANSSEN

45E
60E
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90E
105E
Oersted
Chevallier
Carrington
Schumacher
Zeno
Vashakidze
F A B R Y
Rayet
Shuckburgh
Hooke
Sisakyan
Franklin
MESSALA
R I E M A N N
Sumner
Berzelius
G A U S S
Rynin
Giordano Bruno
Bernoulli
Geminus
VESTINE
SZILARD
Berosus
Burckhardt
Hahn
MAXWELL
Debes
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SEYFERT
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CLEOMEDES
Espin
Delmotte
Seneca
Liapunov
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Lomonosov
Artamonov
Eimmart
Plutarch
Edison
Deutsch
Tisserand
Hubble
Dziewulski
Maly
M A R E
Cannon
Peirce
(Sea of Crises)
Al-Biruni
Popov
Chang Heng
Proclus
Alhazen
Goddard
Möbius
FLEMING
Yerkes
C R I S I U M
Glaisher
Picard
Hansen
MARE MARGINIS
Ibn Yunus
Ginzel
Kostinsky
Lick
Condorcet
(Border Sea)
Hertz
Auzout
Dreyer
Moiseev
da Vinci
Firmicus
MARE
NEPER
UNDARUM
Jansky
Taruntius
Apollonius
Dubiago
Erro
MARE
Saenger
Schubert
Babcock
MARE
SPUMANS
M A R E
Webb
Messier
Maclaurin
GILBERT
(Smyth's Sea)
Parkyne
Wyld
Saha
Buisson
S M Y T H I I
Lubbock
(Sea of Fertility)
Einthoven
KASTNER
HIRAYAMA
FECUNDITATIS
LANGRENUS
Goclenius
La Pérouse
Gansky
Langemak
Brunner
Magelhaens
Kapteyn
PASTEUR
Meyne
Bellot
Ansgarius
Khwolson
Crozier
Lohse
Lamé
Ritz
Mc Clure
VENDELINUS
Backlund
Colombo
Cook
Behaim
HILBERT
Gibbs
Monge
Holden
SKLODOWSKA
BALMER
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Santbech
Biot
HECATAEUS
Kovalsky
Izsak
Wrottesley
CURIE
Alden
Perelman
Borda
PETAVIUS
Titius
Scaliger
Schaeberle
PHILLIPS
Lauritsen
Palitzsch
HUMBOLDT
BARNARD
Hase
Legendre
Snellius
Donner
M I L N E
Stevinus
Adams
Parkhurst
A B E L
M A R E
Trodolj
FURNERIUS
(Southern Sea)
Gernsback
Rheita
Bjerknes
Fraunhofer
Marinus
A U S T R A L E
Gum
Young
Jenner
LAMB
Pogson
Hamilton
Vega
OKEN
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60E
75E
90E
105E


135E
150E
165E
180
CAMPBELL
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Langevin
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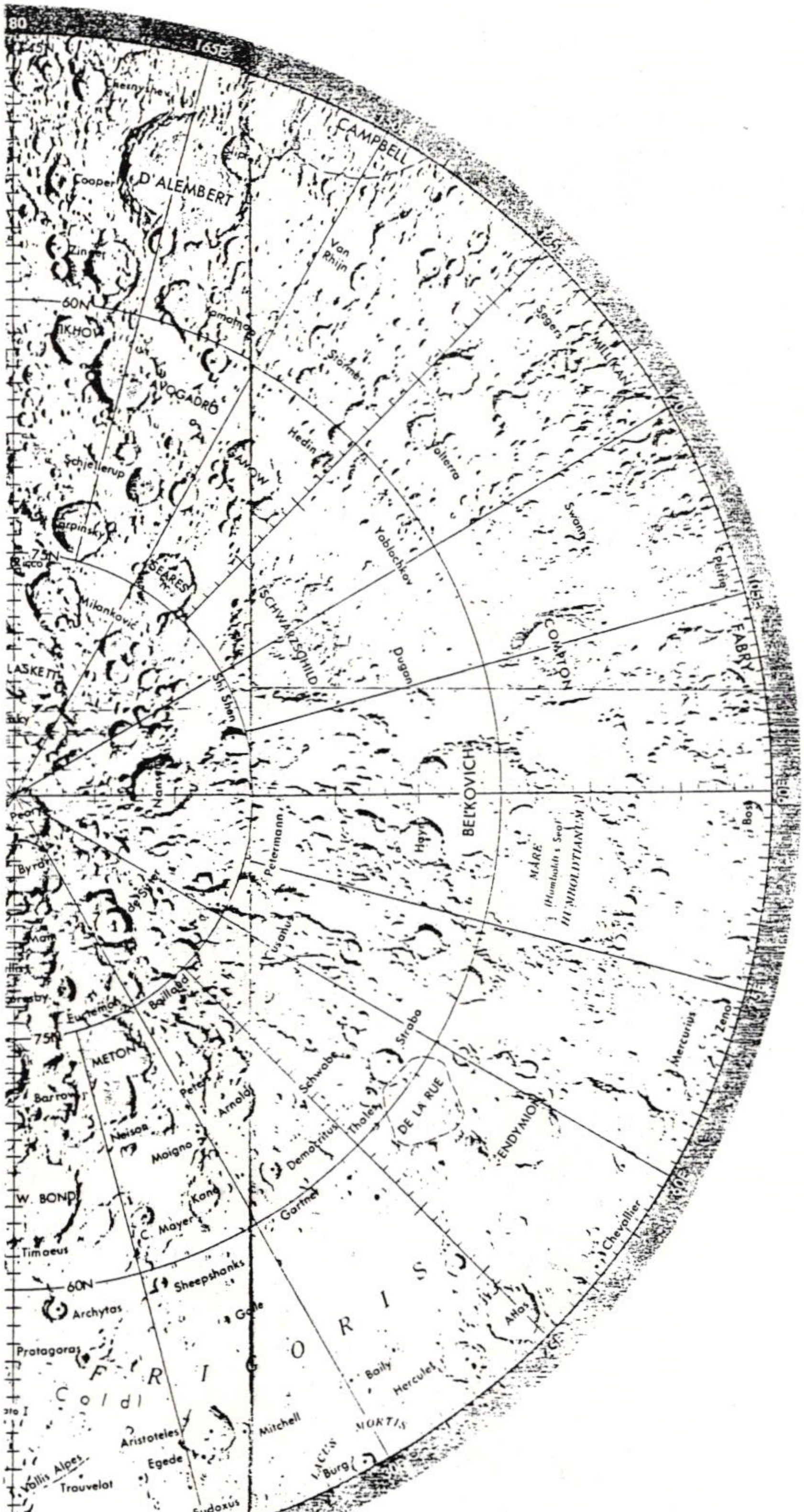
LEY
H.G. WELLS
Becquerel
WIENER
Von Neumann
Golovin
Champollion
Teslo
KURCHATOV
Appleton
Hutton
Van Maanen
Nikolaev
Hogg
Nijland
Steno
Nušl
SHAJN
Feoktistov
Larmor
MARE
Moscow Sea
MOSCOVIENSE
Tereshkova
Titov
TRUMPLER
Innes
Fraundlich
Komarov
Meggers
Shatalov
TIHOMIROV
VERNADSKY
Siedentopf
Belyaev
Buys-Ballot
Konstantinov
Olcott
Leonov
Nagaoka
Zernike
Gavrilov
Tsu Chung Chi
Van Gent
ANDERSON
Hoffmeister
Kohlschütter
Spencer Jones
Sharonov
Meshchersky
Vetchinkin
St. John
Papaleksi
Safarik
OSTWALD
Mills
Stein
Valier
Morozov
MENDELEEV
Schuster
Henderson
Dufay
Green
Mandel'shtam
Hartmann
Abul Wafa
Gregory
Coriolis
Glasenap
Schliesinger
Vening Meinesz
Becvar
Prager
Pannekoek
Dewar
Ventris
Vil'ev
Daedalus
Love
CHAPLYGIN
Stratton
Dellinger
Perepelkin
Lane
Ten Bruggencate
Marconi
KEELER
HEAVISIDE
Chauvenet
Danjon
Beijerinck
Geiger
Delporte
Denning
Litke
AITKEN
FERMI
Pirquet
GAGARIN
TSIOLKOVSKY
Cyrano
Levi-Civita
Barbier
Zhirinsky
Waterman
Stark
NEUJMIN
PAVLOV
Sierpinski
VAN DE GRAAFF
Nassau
Holetschek
Subbotin
Zelinsky
O'Day
Lampland
Birkeland
Seidel
THOMSON
Bolyai
EÖTVÖS
MARE INGENII
(Sea of Ingenuity)
Coblentz
JULES VERNE
LEIBNITZ
Obruchev
Lundmark
Ramsay
ROCHE
KOCH
Van der Waals
ORESME
Carver
PAULI
VON KÁRMÁN


165W
150W
135W
120W
105W
90W
75W
60W
45W
30W
15W
CARNOT
ROWLAND
SOMMERFELD
STEBBINS
VAN'T HOFF
DEBYE
EMDEN
Paraskevopoulos
Montgolfier
Wollner
Perrine
Chappell
Kirkwood
Schlesinger
Gullstrand
Bolochievicz
Kramers
Coulomb
Weber
Barton
STEFAN
Hippocrates
Wiesenlsew
Thiessen
Poinsot
Ellison
Omar Khayyam
XENOPHANES
VOLTA
Cremona
PYTHAGORAS
Desargues
Pascal
Galvani
REGNAULT
GERARD
Cleostratus
BABBAGE
Oenopides
Anaximenes
Anaximander
Carpenter
Anaxagoras
Philolaus
Epigenes
GOLDSCHMIDT
Markov
OCEANUS
(Ocean of Storms)
PROCELLARUM
Dechen
SINUS
(Bay of Dew)
RORIS
SOUTH
HERSCHEL
Robinson
Horrebow
Harpalus
Foucault
Bouguer
Bianchini
Sharp
Rima Sharp I
La Condamine
Fontenelle
BIRMINGHAM
M A R E
PLATO
Maupertuis
MONTES
SINUS
(Bay of Rainbows)
IRIDUM
JURA
MARE
IMBRIUM
(Sea of Rains)
Rima Plato
Challis
Hermite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AVOGADRO
Störmer
Hedin
Volterra
Schjellerup
GAMOW
Swann
Karpinsky
Yablochkov
75N
SEARES
Milankovic
SCHWARZSCHILD
COMPTON
FABRY
Dugan
Shi Shen
Nansen
Peary
BEL'KOVICH
Petermann
Hayn
MARE HUMBOLDTIANUM
Bose
Byrd
de Sitter
Cusanus
Euctemon
Baillaud
75N
METON
Strabo
Mercurius
Zeno
Barrow
Peters
Arnold
Schwabe
Thales
DE LA RUE
ENDYMION
Neison
Moigno
Democritus
W. BOND
Kane
Gartner
C. Mayer
Chevallier
Timaeus
60N
Sheepshanks
Archytas
Gale
Atlas
Protagoras
F R I G O R I S
Coldi
Baily
Hercules
Aristoteles
Mitchell
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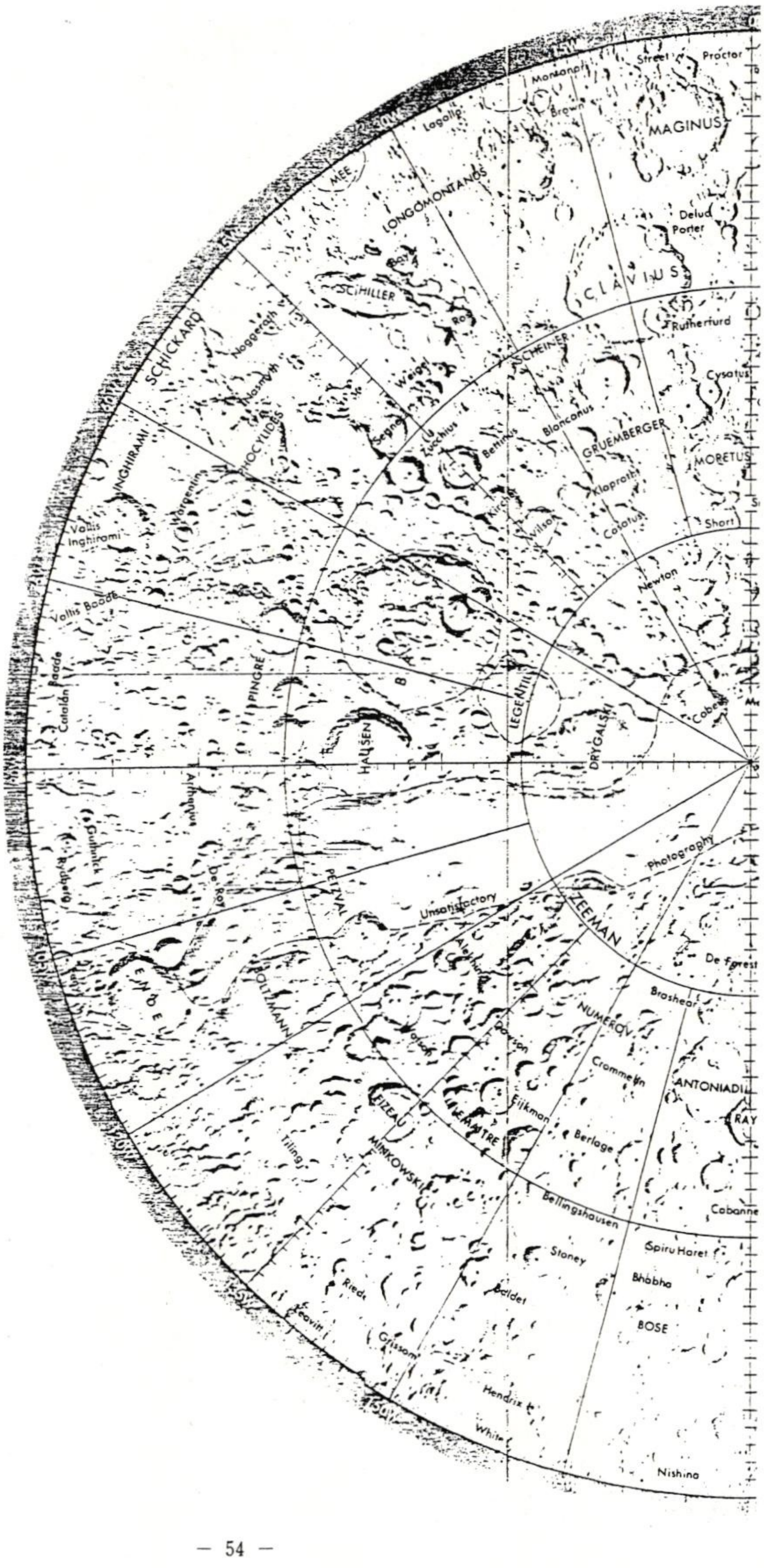
Egede
Burg
Vallis Alpes
Trouvelot
ALPES
Eudoxus
45N


Proctor
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MAGINUS
MEE
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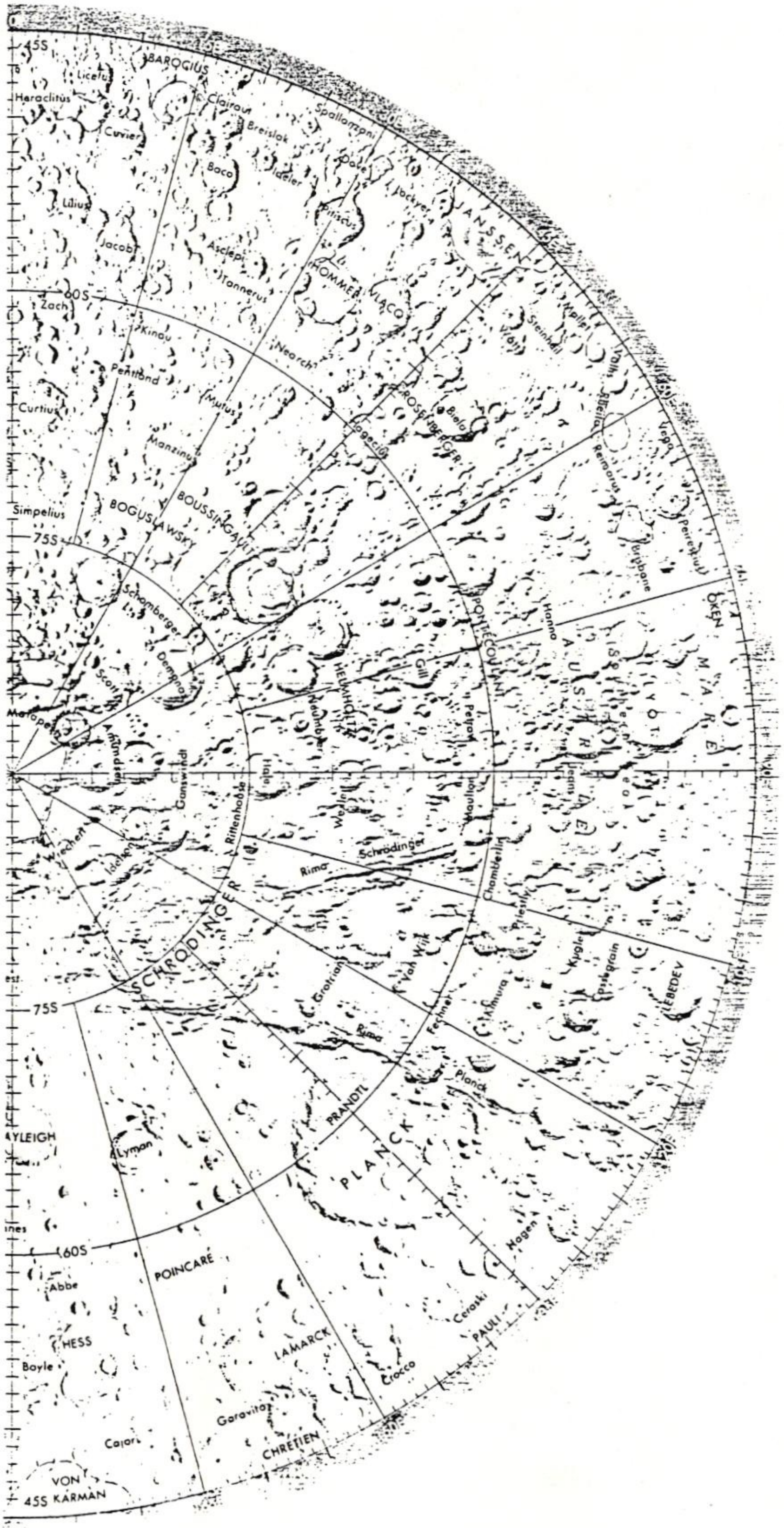
Deluc
Porter
CLAVIUS
SCHILLER
Rutherfurd
SCHICKARD
Noggerath
SCHEINER
Cysatus
Weigel
Nasmyth
Segner
Zucchius
Bettinus
Blancanus
GRUEMBERGER
MORETUS
INGHIRAMI
PHOCYLIDES
Klaproth
Wargentin
Kircher
Wilson
Casatus
Short
Vallis Inghirami
Newton
Vallis Baade
Baade
Catalán
PINGRE
B
LEGENTIL
DRYGALSKI
Cabeus
HAUSEN
Arrhenius
Graff
Rydberg
De Roy
Photography
PETZVAL
Unsatisfactory
ZEEMAN
De Forest
Brashear
NUMEROV
Crommelin
ANTONIADI
RAY
FIZEAU
LEMAITRE
Eijkman
Berlage
Tiling
MINKOWSKI
Bellingshausen
Cabannes
Stoney
Spiru Haret
Bhabha
Riedel
Baldet
BOSE
Leavitt
Grissom
Hendrix
White
Nishina


45S
BAROCIUS
Licetus
Heraclitus
Clairaut
Cuvier
Breislak
Spallanzani
Baco
Ideler
Lilius
Pitiscus
JANSSEN
Jacob
Asclepi
HOMMEL
Tannerus
VLACQ
60S
Zach
Kinau
Nearch
Steinheil
Watt
Pentland
Curtius
Mutus
ROSENBERGER
Biela
Hagecius
Vega
Manzinus
Simpelius
BOGUSLAWSKY
BOUSSINGAULT
75S
Schomberger
Brisbane
PONTECOULANT
Hanno
OKEN
Demonax
Scott
Gill
Malapert
HELMHOLTZ
Neumayer
Petzval
Amundsen
Ganswindt
Hale
Rittenhouse
Moulton
Wiechert
Idel'son
Schrödinger
Rima
Chamberlin
SCHRÖDINGER
Priestly
Kugler
Lebedev
Van Wijk
Grotrian
Fechner
Planck
PRANDTL
PLANCK
Lyman
Hagen
60S
POINCARÉ
Abbe
Ceraski
PAULI
HESS
LAMARCK
Boyle
Crocco
Garavito
Cajori
CHRETIEN
VON KARMAN
45S

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