BUFFALO ASTRONOMICAL ASSOCIATION INC.
BUFFALO MUSEUM OF SCIENCE
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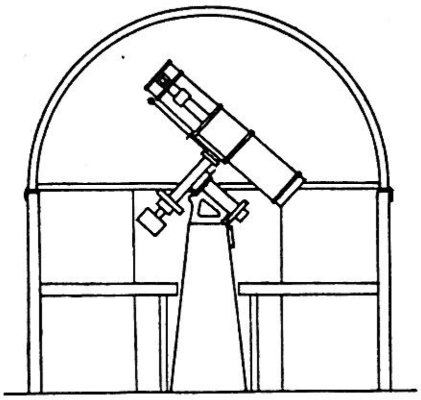

THE SPECTRUM

FEBRUARY 1969

FERBUARY MEETING: For our February meeting (Friday, February 14, 1969, 8:00 PM) we welcome two of our younger members to the speaker's rostrum, JOHN RIGGS and DALE HANKIN. John's topic will be "Deep Sky Observations," while Dale will discuss "Lunar Studies." Both of these young astronomers have done excellent work in their respective areas of interest, and they both are very fine and assiduous observers. Surely our association can perform no nobler task than to encourage young, would-be astronomers in their interests and to provide for them a platform where they may discuss their work. And surely, no member of our association would want to miss this opportunity to hear what the younger set is doing. This is your chance to bridge the generation gap - it promises to be a very informative meeting and we are happy to welcome JOHN RIGGS and DALE HANKIN!

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IN MEMORIAM - FRED T. HALL, 1914 - 1969.

It is with profound regret that we record the sudden and unexpected death of Fred T. Hall, Director of the Buffalo Museum of Science since 1951. The loss of Mr. Hall to the Museum and to amateur astronomy cannot be expressed adequately in a few words. Through his vision and energy he brought the Museum to life and caused it to move forward on all fronts. He had many interests, and through them he tried as best as he could, and at times against great odds, to equally modernize all areas of interest represented by the Museum. From the beginning he took an active interest in astronomy and under his leadership the Kellogg Observatory was modernized, an astronomical library was obtained, and the Solar Observatory was added. Very recently he became interested in obtaining astronomical facilities for the Museum's Nature Study Area near East Aurora. He was a human being of great compassion, always interested in the well-being of his staff. We shall miss him greatly. To his staff and particularly to his family we extend our profound sympathy.

NOTICE: BAA SECTIONS:

Members may wish to join one or more of the three sections currently active: the INSTRUMENT section (Ed Lindberg), the ADVANCED STUDY section (Ron Clippinger), and the OBSERVING section (Ernst Both). While the meeting times are somewhat flexible, the INSTRUMENT and ADVANCED STUDY sections meet on the third Friday of the month, and the OBSERVING section usually meets on the first Friday of the month. In view of the semi-flexibility of the meeting times, interested members should give their name and phone number to the respective leaders, so that they may be informed properly. The OBSERVING section will be concentrating on a study of lunar domes and is open only to those members who are both interested in observing as well as in possession of adequate instrumentation. We hope to report on the activities of these sections from time to time.

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* THE TROUBLE WITH MASCONS * By Kurt Erland.

MASCON = large scale (high density) mass concentrations beneath the circular lunar maria.

The lunar Orbiter satellites, publicly well-known for their high-resolution and often spectacular photographs of the lunar surface, were also designed to provide information concerning the roughness of the Moon's gravity field - of interest in any manned or unmanned lunar exploration because of the perturbations produced on the trajectory of any probe. What originally started as an "operational nuisance" in the tracking of the Orbiter satellites, eventually resulted in the recognition of the mascons and opened the door to a new field of lunar studies, lunar gravimetrics.

During the tracking of Orbiter V, it was found that the space craft accelerated in an unexpected manner whenever it passed over certain areas of the Moon. An analysis by Muller and Sjorgen (see references at the end of this article) of 80 consecutive orbits of this lunar satellite (closest approach to the Moon's surface = 100 km, period = 3h11m) over a period of 10 consecutive days indicated the presence of large mass concentrations under the maria Imbrium, Serenitatis, Crisium, Nectaris, and Humorum, as well as under the far-side Mare Orientale (for a discussion of this very interesting lunar feature see SKY AND TELESCOPE, January 1969, pp. 4-7, and SKY AND TELESCOPE, February 1964, p. 89). The theoretical model used in tracking this satellite, considered the effects of a triaxial Moon, coupled with the perturbations produced by the Earth, the Sun, and the planets Venus, Mars, Jupiter, and Saturn. Deviations from this theoretical model would have to result from peculiarities in the Moon's gravitational field. Analysis of over 9,000 data points indicated that the observed accelerations (above those produced by the expected ingredients of the theoretical model) were due to mass irregularities underneath the surface of the Moon, and indications were that these occurred somewhere between 25 and 125 km under the surface. Since the altitude of Orbiter V above the lunar surface changed continuously, the observed accelerations were normalized for a mean altitude of 100 km on the assumption that the mass concentrations occurred at a depth of 50 km.

Muller and Sjorgen also discovered smaller mascons underneath Sinus Aestuum and near Sinus Medii, both of which may represent originally circular maria which later became buried. From the large rate of change in the spacecraft acceleration when passing over these mascon-areas, it appears that the physical extent of the typical mascon is rather small, say between 50 and 200 km. For example, assuming a depth of 50 km (as was done by Muller and Sjorgen), the mass of the Imbrian mascon would be 20×10^{-6} lunar masses or 1.46×10^{21} grams. This would be equivalent to a spherical nickel-iron object about 100 km in diameter, although the observations actually indicate an oblong object of unknown composition. The mascons raise interesting and fundamental questions: Do they represent the original asteroids which collided with the Moon, producing these maria (as some investigators envision the origin of the lunar seas)? If they do not represent the asteroid (or meteoroid) itself, what are they, and how were they formed? In view of their presence, can one really maintain the occurrence of large-scale lava flows in the Moon's evolutionary past? Etc., ets... Muller and Sjorgen raise these and similar questions but they do not attempt to answer them. However, a number of investigators attempt some answers in the December 20, 1968 issue of Science, which we shall briefly review here.

J. Gordon Stipe, of Boston University, has carried out experiments with impacting steel projectiles, ranging in diameter between 1.27 and 15.5 cm, and in mass between 8.35 grams and 44 kg. Impacting these into concrete, at velocities of around 1.0 km/sec produces no deformation and no excessive heating in the projectile. In soil, however, the projectiles tend to break into pieces and/or deviate from a straight path as well as penetrating to smaller distances. Also smooth spheres penetrate farther than rough objects (akin to meteorites). Extrapolating to lunar sizes, Stipe finds that the object responsible for Mare Imbrium would have a (spherical) diameter of 61.2 km, at a depth of between 450 and 670 km, with a mass of 9.3×10^{20} grams. If the object is irregular in shape (as one might expect) the depth could be considerably less, i.e. approaching the range indicated by Muller and Sjorgen.

J. E. Conel and G. B. Holstrom of the Jet Propulsion Laboratory indicate that the mascon-effect need not be produced by the impacted original meteorite - a similar effect would be produced by a disk of dense lunar rock embedded in less dense rock and located near the surface of the maria. For Mare Serenitatis, for example, the fill would turn out to be 600 km in diameter and 8 km thick, with a density of 3 gm/cm^3 surrounded by material with a density of 2 gm/cm^3. According to their view the original meteorite will have been destroyed by the impact.

A somewhat similar conclusion is reached by Ralph B. Baldwin, one of the best-known proponents of the Impact Theory. He suggests that the mascon-effect is produced NOT by buried meteoritic bodies but rather by high-density lava lenses at depths down to 82 km. Using Mare Imbrium as an example, Baldwin reconstructs the following events in its formation: A giant impact forms the Mare Imbrium which originally has a depth of 50 km and was not lava-filled (i.e. the impact was dry). The original mare begins to distort in an isostatic way, the deformation slowing down with time. Several major flows of high density lava fill the low spots and subsidence and compaction takes place. Due to the increasing load of high density matter, the crater bottom is continuously depressed. In this way a dense lens forms, centered in the crater and producing the observed mass excess which would vary with the cube of the diameter. He maintains that if the impacts occurred at velocities of 2 km/sec or greater, "the back pressures generated should have been great enough to cause the asteroid to lose cohesion and to turn itself inside out" so that "a considerable fraction of the mass would have been backfired out of the crater."

Diametrically opposed stands another well-known exponent of the Impact Theory - Harold C. Urey, who draws far-reaching conclusions from the mascons. It will be remembered that it was Urey who originally proposed a low-angle, low-velocity collision between the Moon and an asteroid which produced Mare Imbrium and which gauged out the Sinus Iridum (which, incidentally, does not indicate the presence of a mascon). After shaping the Sinus Iridum, the asteroid buried itself south of the Imbrian center, flattening out below the surface and leaving a high density mass buried there. Precisely because of the presence of the mascons, says Urey, there could not have been any extensive lava flows on the lunar surface, for the mascons would have to sink toward the Moon's center in order to displace massive flows toward the surface. This situation would eventually lead toward an isostatic equilibrium and would not leave any mass concentrations. Urey concludes that "the great smooth maria areas of the Moon are not lava flows, but owe their existence to some other process ..," probably surface water. He calculates that the Imbrian mascon is a flat, circular slab of chondritic material, 670 km in diameter and 4 km thick, having a mass of 5×10^{21} grams and located near the center.

Thus the mascons are an exciting find, providing us with valuable clues about the Moon's early history. Gravimetric observations on the lunar surface itself, coupled with core sampling may eventually tell us more about their true nature.

References:

P. M. Muller and W. L. Sjorgen, "Mascons: Lunar Mass Concentrations," Science 161: 680-684, 1968.
J.G. Stipe, "Iron Meteorites as Mascons," Science 162: 1402-1403, 1968.
J.E. Conel and G.B. Holstrom, "Lunar Mascons: A Near-surface Interpretation," Science 162: 1403-1405, 1968.
J.A. O'Keefe, "Isostasy on the Moon," Science 162: 1405-1406, 1968.
R.B. Baldwin, "Lunar Mascons: Another Interpretation," Science 162: 1407-1408, 1968.
H.C. Urey, "Mascons and the History of the Moon," Science 162: 1408-1410, 1968, and "The Contending Moons," Astronautics and Aeronautics 7: 37-41, 1969.

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For those of our members who are interested in Flying Saucers (but do not admit to it in public) we recommend plowing through the 965 pages of E. U. Condon's SCIENTIFIC STUDY OF UNIDENTIFIED FLYING OBJECTS, a Bantam book at $ 1.95 - a must. Reviewed soon.

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DUES ARE DUE - SEE MRS. GEIGER AND MAKE SURE WE HAVE YOUR CORRECT ADDRESS ON OUR LIST

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