LETTERS TO THE EDITOR

ASTRONOMY

Impacts on the Earth and Moon

ALTHOUGH nine out of ten of the average meteorites are stoney, the larger objects which collide with the Earth may be predominantly iron. This reversal in characteristics is suggested by the different size law for stone and iron meteorites. The number of impacts on the Earth's

result by other methods. The largest object passing close to the Earth is the asteroid Eros with a mass of approximately 3×10^{16} kg. The distance of closest approach is 2.2×10^7 km, and, since the search for close approaching asteroids has been confined mainly to the northern hemisphere, the collecting area is 2.1×10^{16} km². The periodicity is 2 years and the rate for $m_{\infty} \geq 3 \times 10^{16}$ kg is 2.4×10^{-17} (km⁻² year⁻¹). This is in fair agreement with equation (2). It is probable that very few objects with mass greater than

Fig. 1

surface, N (km⁻² year⁻¹), with initial mass greater than m_{∞} (kg), is at the present time:

$$\text{stones: } \log_{10} N = -3.73 - \log_{10} m_{\infty} \quad (1)$$

$$\text{irons: } \log_{10} N = -5.61 - 0.7 \log_{10} m_{\infty} \quad (2)$$

These equations can be derived from existing meteorite data^{1,2} by assuming that 90 per cent of a stone and 80 per cent of an iron are ablated.

In Fig. 1 the values found from equations (1) and (2) are compared with the data of H. Brown³ and Opik⁴. The influx rate of stones (1) agrees with other determinations over the range 10⁴–10¹⁴ kg. However, the new value for iron meteorites represents an upward revision of the estimated rate. At $m_{\infty} = 10^6$ kg the number of irons is equal to the number of stones and at $m_{\infty} = 10^{10}$ kg the irons outnumber the stones by 10 : 1. It is interesting to note that the rate of collision with cometary nuclei is comparable with that of stony meteorites at the upper end of the size range. We may assume the rates for the surface of the Moon to be 1/2 of the rates for the Earth, thus making allowance for the effect of concentration caused by the Earth's gravitational field.

The extrapolation beyond the range of observation is considerable and it is of interest to attempt to confirm this

or equal to Eros remain undetected in the vicinity of the Earth's orbit. However, there remains the statistical uncertainty in the small number of events. A similar calculation for the Apollo group gives a value that is some 10² times lower than the prediction. Although the number of events is greater this value is probably less reliable than the value derived from Eros. The search for the smaller and faster moving objects is by present estimates far from complete.

We may tentatively conclude that the near-approaching asteroids are iron objects, though, of course, the bulk of the material which remains in the asteroid zone may still be of non-metallic composition. For impacts that occur on the Earth's surface at a rate of 1 every 5 × 10⁶ years, such as the terrestrial events suggested by some authors as the cause of tektite fields, the irons may outnumber the stones by as much as 100 : 1. If we assume that equations (1) and (2) are approximately true for the past then we may estimate the maximum size of object that has collided with the Earth during its geological history. The largest object to collide with the Earth is of mass 10¹⁷ kg. The Moon has probably suffered one collision with an object comparable in size to Eros, 10¹⁶ kg.

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¹ Hawkins, G. S., *Astro. J.*, **65**, 318 (1960).

² Hawkins, G. S., *Lunar and Planetary Exploration, North American Aviation*, **2**, 5 (1961).

³ Brown, H. S., *J. Geophys. Res.*, **65**, 1679 (1960).

⁴ Opik, E. J., *Irish. Astro. J.*, **5**, 35 (1958).

RADIOPHYSICS

Long Baseline Interferometry of Jovian Decametric Radio Bursts

DURING the 1962 opposition of Jupiter we made some exploratory observations with a long baseline interferometer in an attempt to obtain information on the sizes and distribution of the decametric burst sources. The observations were made at 19.7 Mc/s with a north-south baseline of 32.3 km, equivalent to 1940 λ at the declination of the planet. They have shown that successful interferometry is possible at these large distances in spite of complications due to ionospheric irregularities. The angular diameter of a burst source was found to be