THE CYRILLID SHOWER: REMNANT OF A CIRCUMTERRESTRIAL RING? J. A. O'Keefe, NASA, Mail Code 681, NASA Goddard, Greenbelt, MD 20771

On February 9, 1913, a few minutes after 9 PM, Eastern Standard time, the David Dunlap Observatory, in Toronto, received a large number of telephone calls about an extraordinary meteor shower, which had just passed over, lasting about five minutes. The following day, the Canadian newspapers, reporting the shower, carried a request from the Observatory for reports of sightings. Reports were received from Saskatchewan, Ontario, New Jersey, and Bermuda; everywhere the meteors were described as in level flight. C. A. Chant (1), the director of the Observatory, deduced that the group of meteors had been in orbit around the earth before entering the atmosphere. He drew a great circle (the Chant trace) which fitted the observations available to him. Gaps in the path were later filled: by A. D. Mebane (2) from local newspapers in New York, Pennsylvania, Michigan, Wisconsin, Minnesota; by W. F. Denning (3) from two ship reports beyond Bermuda, the farthest off Cape Sao Roque, Brazil; by W. F. Pickering (4) from three ship reports between New York and Bermuda; by J. O'Keefe (5) from a single local newspaper in Alberta. The name Cyrillids was proposed (6) for these meteors. Further references will be found in (6).

The interpretation of these data in terms of a group of natural satellites of the earth was challenged by C. C. Wylie (7), who considered the event a normal meteor shower. The rival interpretations were tested (6) first by an examination of all of the metropolitan dailes in the U.S. which are filed at the Library of Congress, and second by examination of all Weather Bureau reports for the northern U. S. Both studies showed that accounts of the Cyrillids are to be found along the Chant trace, and nowhere else.

Other features of the phenomenon as described by Chant's correspondents support the interpretation as natural satellites, especially the conspicuously slow apparent motion; the long duration of visibility (up to about 1 minute for individual meteors); and the fact that the last subgroup of this event was further west than the others, as would be expected due to the rotation of the earth.

Chant suggested that the meteors had been in heliocentric orbit; that they had encountered the earth's atmosphere and had been converted to satellite orbits. This hypothesis can be shown to be wrong. King-Hele points out (8) that atmospheric drag will not convert an elliptic orbit into a circular orbit. It is true that in an elliptic orbit, the loss of energy is greatest at perigee and that the result is to lower the apogee and so to diminish the eccentricity. But as the apogee approaches the same height as the perigee, the drag effects of apogee increase; these lower the perigee and lead to the rapid fall of the satellite. The point to keep in mind is that in such processes the atmospheric scale height of about 10 kilometers is small compared with the typical orbital dimensions of 10,000 kilometers.

Thus the Cyrillids could not have resulted from capture of ordinary meteors by the earth's atmosphere. Neither could they have reached the observed closely circular orbit by atmospheric drag starting

from the ejecta of a lunar volcano. But if the lunar volcano had ejected enough material in the direction of the earth, then collisions between the particles would have brought the whole cloud into the form of a ring, like the rings of Saturn, in which the individual pieces move in accurately circular orbits. Then the Cyrillids, or more likely their parent mass, might have survived after the smaller particles had been removed by atmospheric drag.

An obvious criticism of this hypothesis is that the orbits of the Cyrillids are inclined at an angle of about 52^{0} to the plane of the earth's equator, whereas the orbits of particles in the known rings are close to the plane of the equator of the primary. The reason may be that the earth's flattening of 1/300 is an order of magnitude less than the flattenings of the giant planets. It is this flattening which is responsible for the weak forces which push the orbit into the plane of the equator of the primary. At the same time, the atmospheric scale height, which determines how much gas will be at the distance of the satellite, is much larger, in proportion to the dimensions of the primary and hence the life of the ring is shortened. It may be that there was not enough time for the rings to migrate into the orbital plane.

The reason for reconsidering the Cyrillid problem at this time is the work of Izokh and Le (9), indicating that the most recent tektite strewn field fell to earth only 10,000 years ago, not 700,000 (9).

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