THE SONIC BOOM OF THE BOVEEDY METEORITE

(with some remarks concerning scientific prejudice)

The Boveedy (Bovedy) meteorite fall of 25th April, 1969, will go into the records of meteorites as a unique event: inadvertently, by sheer luck, its sound was recorded on magnetic tape. This is the first recording of a meteorite ever made, and the precision of the recording overwhelmingly compensates for the somewhat contradictory visual observations of casual eye-witnesses caught by surprise at the apparition (*see* preceding article in this issue). Of course, the recording of sound can contribute little toward the determination of the flight trajectory, but it opens up a hitherto unexplored avenue of meteorite physics.

Miss Eileen M. Brown, of Bangor, County Down, Northern Ireland, an employee of the Telephone Exchange in Belfast, in pursuit of her hobby of recording bird songs was on that evening exposing as usual her tape recorder in the garden when the idyllic evening calls of the birds were suddenly interrupted by thunder. She thought, indeed, that it was thunder albeit from a clear sky. Yet her father's dog thought differently—instead of panicking and seeking refuge at his master's feet as in the case of real thunder, he did not show any signs of alarm. So father concluded that it was not thunder, and indeed he and his dog were right. They later learnt that it was the sonic boom of the meteorite whose visual effects they had somehow missed. It was like an artillery cannonade, perhaps similar to the sonic boom of the Concorde super-aircraft which recently has been disturbing the peace of the inhabitants of the same region on both sides of the Irish Channel.

Copies of the recording were prepared by Miss Brown and supplied on demand to several interested persons and institutions all over the world. One of the copies is at Armagh Observatory and Planetarium. Dr. P. M. Millman, of the National Research Council, Ottawa, Canada, and one of the internationally most distinguished meteor workers, has made an analysis of the recording by reproducing it on paper graph showing amplitude versus time, through the intermediary of a high-speed tape recorder ("time enlargement") (P. M. Millman, "A Tape Recording of the Belfast Meteorite", *J. Roy. Astron. Soc. Canada,* 64, pp. 57-59, February 1970). The results, with a general description of the event, are as follows.

On the tape, among bird voices of the April evening, there occurs at first interference by a car passing the street in front of the garden, but this vanishes at the right time to give again prominence to the birds. Then suddenly are heard the "gunfire" reports of the meteorite, three strong sharp detonations within less than half-a-second interval, followed by weaker ones during a few seconds. Some five seconds after the "thunder" there followed barking of dogs aroused by it (these neighbourhood dogs were at a distance of about 50-60 m). The adjoining table lists these events as registered on the tape, according to Dr. Millman's analysis.

Sound Recording of the Meteorite

(according to P. M. Millman) (abridged)

Event	Bird call	Meteorite detonations				. . . .	Dog barking	
Time, sec	—8.00	+0.00	0.15	0.38	0.85	1.07	5.84	5.88
Frequency per sec	3500	300	400	320	250	270	850	740
Strength	2.5	7	7	8	5	5	5	4
Duration, sec	0.05	0.02	0.06	0.11	0.02	0.02	0.03	0.03

In the second line, the time in seconds is reckoned from the first meteorite detonation. Thus, the sample of bird call (there were several in succession) was taken 8 seconds before the first boom. The frequency (in Hertz, cycles or vibrations per second) is a mean value for the event; only when the vibrations are equidistant and regular, is the frequency equivalent to a musical pitch (440 per sec for the tuning A). The bird call may be nearest to a musical sound. The other sounds are " noise " consisting of a superposition of irregular vibrations, without a musical tone to be assigned to them. The " strength " is the maximum amplitude as measured on the recording and is given in arbitrary relative units; the force of sound can be assumed to be proportional to the square of the amplitude.

These recorded happenings are well in line with what is generally qualitatively known about meteoritic sound phenomena. Thus, on p. 58 of the classical work by E. A. Krinov (" Foundations of Meteoritics ", in Russian, 391 pp., Moscow 1955) we read in translation: "A few minutes after the disappearance of the fireball, the eye witnesses are hearing sharp detached detonations reminiscent of explosions or artillery fire. Usually there are three detonations, followed by thunderous rumbling, which is gradually decreasing . . ."

Another mysterious kind of meteoritic sound phenomena has been often reported, described as hissing, crackling sounds, or like the tearing of cloth, lowing of oxen, etc. These are heard *simultaneously* with the visible phenomenon, thus propagating with the velocity of light, one million times faster than sound. They have been therefore looked upon sceptically by some researchers. If they are real, they must be due to some electromagnetic radiation, possibly microwave emission from the meteor trail which directly influences the brain. These " electrophonic phenomena " appear to be real, according to P. L. Dravert and I. S. Astapovitch (*see* Krinov, *loc. cit.,* p. 57). Certainly these could never be recorded on the tape which reacts only to ordinary sound.

In the light of this, somewhat comical appears the refusal by a geologist of good standing to accept the evidence of Miss Brown's tape recording because it did not show " what all scientists are hoping to hear ", sounds like " the lowing of oxen ", etc. Scientific prejudice has thus deprived him, or his institution of the most remarkable and unique document of its kind.

On this occasion, I am tempted into a digression regarding preconceived ideas of scientists. Another example, again in the realm of meteoritics, happened about two decades ago, when a London science news bulletin started a series of articles by a professional geologist, purporting to show (against all the existing evidence) that the known meteor craters on earth are not of meteoritic origin. To the credit of the news bulletin, the series was stopped very soon with a proper disclaimer.

There have been voiced some misgivings that in the first lunar Apollo landings no scientists, especially no geologists, were allowed to participate. Undoubtedly in the future these experts must be given a chance to apply their vast knowledge and experience in the direct exploration of the lunar surface. However, as regards the first landings, the absence of a scientist with all his preconceived ideas and selectivity may even have been an advantage, in ensuring that the samples of lunar material brought back to earth were representative, non-selective, and not " what all scientists were hoping to find ".

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CELLULAR CONVECTION IN STELLAR ENVELOPES

(Research Note)

D. J. Mullan

Abstract.

Cellular convection in stars has been treated by a theory due to Öpik (1950). The solar convection zone is found to be only 10^4 km deep, reaching a temperature of 9.5×10^4 deg K. These numbers are not sensitive to the free parameters of the theory. Quantitative agreement with solar and stellar observations has been found in more than a dozen observational tests in some of which current theories have failed. This note summarizes the principal results which are in agreement with observations. Details of this study will be published more extensively in the near future.

Models of the envelopes of main sequence stars have been constructed using a cellular theory of convection due to Öpik (1950, 1970). This theory allows for turbulent and radiative exchange of heat between rising and falling gas within a convection cell. Previous discussions of convection in stars have been based mainly on the mixing length theory developed by Vitense (1953; Böhm-Vitense, 1958) in which turbulent exchange in the rising " bubble " is neglected, and laminar flow is assumed to prevail. When turbulent exchange (second-order turbulence) is admitted, using a coefficient determined experimentally by Öpik (1967), the efficiency of convection falls by a factor of up to 30 relative to that assumed by the conventional mixing length theory.

The author has undertaken the computation of models using Öpik's