ASTROPHYSICAL IMPLICATIONS OF PERIODICITY

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Two remarkable discoveries of the last decade have profound implications for astrophysics and for geophysics. These are the discovery by Alvarez et al[1] that certain mass extinctions are caused by the impact on the earth of a large asteroid or comet, and the discovery by Raup and Sepkoski[2] that such extinctions are periodic, with a cycle time of 26 to 30 million years. This paper assumes the validity of both of these discoveries, and examines the implications. Because the earth is a small target, an immediate conclusion that one can draw is that the impacts must take place as part of a comet or asteroid shower. Analysis[3,4] of the paleontological and geophysical evidence shows that impact craters correlate in age with the mass extinctions, and that they occur in clusters as expected from this model.[5] In addition, the shower model predicts that the extinctions should be stepwise[6], and paleontological evidence verifies this predictions.[5] Correlations between the rate of impacts and the rate of geomagnetic reversals have led to a new model of the reversal process[7], and this has enabled certain peculiar features of the reversals to be understood. Coincidence between the times of the hypothesized showers and the rate of production of H-chondrites has led to a model for the creation of these meteorites.[8] Other astrophysical and geophysical phenomena have been correlated with the mass extinction rate, including passage of the earth through the galactic plane[4], and these will be critically examined; for most of them the supposed correlation will be shown to be invalid or unproven.

Most of the phenomena described above depend not on periodicity, but just on the weaker assumption that the impacts on the earth take place primarily in showers. Stronger conclusions can be reached if the periodicity has a physical origin, rather than being merely a statistical fluctuation[9]. Proposed explanations for the periodicity include galactic oscillations[4], the Planet X model[10], and the possibility of "Nemesis", a solar companion star[11,12]. These hypotheses will be critically examined. Results of the search for the solar companion will be reported.

The Deccan flood basalts of India have been proposed as the impact site for the Cretaceous impact, but this hypothesis is in contradiction with the conclusion of Courtillot et al.[13] that the magma flow began during a period of normal magnetic field. A possible resolution of this contradiction will be proposed.