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The Carancas meteor fall (2007): probability that the meteor fragmented before impact.

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In recent years, numerous bolide sources have been detected by the IMS infrasound arrays. An object entering the atmosphere can typically be detected through its signature infrasound signal provided a detection station is within the vicinity of the object. Any recorded infrasound can be analysed to determine crucial characteristics of the fall; in the study of meteorites, this includes finding the size and daily flux frequency of bolides ablating in the atmosphere or tracing the azimuth trajectory of a meteorite and determining whether such a meteorite experienced significant fragmentation before impact.

For the case of the Carancas meteor fall in Peru, 2007, some authors have argued that the dominant process of the generated sound was due to fragmentation. These conclusions are strongly dependent on the processing of the recorded signals of the Bolivian seismic network and infrasound arrays, and do not substantially rely on existing analytic models within the field of meteor physics.

In our goal of offering an alternative explanation, we have begun analysing the possible N-wave signal created from a single-body source. This task becomes complex as the maximum amplitude and the duration of a possible N-wave signal can be substantially affected by atmospheric conditions as well as the azimuth, the entry speed and angle, and the physical properties of the meteorite. As the characteristics of an N-wave signal far from the source are dependent on the prior propagative behaviour of the signal near the source, additional complexities will also arise from the chosen source model.

A source model can be created for a single body or multiple bodies (if the meteor has fragmented). For both models, it is possible to formulate equations determining the resultant shock wave created by the meteor. The initial strong shock wave in each case becomes a weak shock front which propagates in this way until it reaches the receivers. To model the propagation front, we use a model from Jones (1968) and ReVelle (1976) to find the radial distance at which the strong shock decays into a weak shock. Once weak shock levels are obtained, Whitham's nonlinearization method is then used to determine how the propagation front evolves over the remaining distance to the station.

In this combined model, the matching of the two theories is possible through a shape factor K. By considering the unknown source location and the variation in K within our analytic model, we are able to statistically consider all realizations of the possible N-wave type signals. This includes using our model to find the probability of obtaining a given signal and how the random diameter affects this probability. Through comparison of our results to recorded infrasound data, we aim to show that it is possible that an N-wave type signal could have originated from the Carancas meteor scenario, subsequently implying that there is a probability that the meteorite did not fragment upon entry.