Abstract Submitted
for the DPP14 Meeting of
The American Physical Society

A Quantitative Kinetic Theory of Meteor Plasma Formation[1]
YAKOV DIMANT, MEERS OPPENHEIM, Boston Univ — Every second millions of small meteoroids hit the Earth from space, the vast majority too small to observe visually. Radars easily detect the plasma they generate and use the data they gather to characterize the meteoroids and the atmosphere in which they disintegrate. These diagnostics requires a detailed quantitative understanding of the formation of the meteor plasma and how it interacts with the Earth's atmosphere. Meteors become detectable to radars after they heat due to collisions with atmospheric molecules sufficiently that they begin to sublimate. The sublimated material then collides into atmospheric molecules and forms plasma around and behind the meteoroid. Reflection of radar pulses from the plasma around the descending meteoroid produces a localized signal called a head echo. This research applies kinetic theory to show that the meteoroid plasma develops over a length-scale close to the ion mean free path with a non-Maxwellian velocity distribution. This analytical model will serve as a basis for quantitative interpretation of the head echo radar measurements, the ionization efficiency (called the Beta parameter), and should help us calculate meteoroid and atmosphere parameters from radar head-echo observations.

[1]Work supported by NSF Grant AGS-1244842.

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Date submitted: 10 Jul 2014 Electronic form version 1.4