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Asymptotics for spherical particle motion in a spherically expanding flow

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In the context of an increasing number of complex multiparametric dust coma models, it was found convenient to construct an elementary model with a minimum number of parameters selected to represent the key processes acting on the dust (see [1]). The model outputs can be used as a reference evaluation of these processes with rough estimates of the resulting dust properties, e.g. velocity. The present work introduces three universal and dimensionless parameters, which characterize the dust motion in an expanding flow and computes, as a function of these parameters: 1) the dust terminal velocity; 2) the time to acquire it; and 3) the distance at which it is acquired. The motion of dust grains is presented as a system of dimensionless ordinary differential equations, the solution of which depends upon the above mentioned three parameters. The numerical integration of this system was performed over a wide range of parameter space covering the whole range of physically possible conditions. Precomputed results of dust terminal velocity, time and distance at which it is reached are presented in dimensionless form. To obtain dimensional values for a particular case it is sufficient to perform algebraic operations.

In agreement with our model: 1) GIADA dust particle speed measurements are consistent with the calculated terminal velocities; 2) OSIRIS data constrain the dust acceleration limited within six nuclear radii for a broad range of particle sizes.

References

[1] Zakharov, V.V., et al.: Asymptotics for spherical particle motion in a spherically expanding flow, Icarus, Volume 312, p. 121-127, 2018