Computing the dust distribution in the bowshock of a fast moving, evolved star

A.J. van Marle[1], Z. Meliani[1], R. Keppens[1], and L. Decin[2]

1 - Centre for Plasma Astrophysics, K.U. Leuven, Belgium
2 - Astronomical Institute, K.U. Leuven, Belgium

We study the hydrodynamical behavior occurring in the turbulent interaction zone of a fast moving red supergiant star, where the circumstellar and interstellar material collide. In this wind-interstellar medium collision, the familiar bow shock, contact discontinuity, and wind termination shock morphology forms, with localized instability development. Our model includes a detailed treatment of dust grains in the stellar wind, and takes into account the drag forces between dust and gas. The dust is treated as pressureless gas components binned per grainsize, for which we use ten representative grainsize bins. Our simulations allow to deduce how dust grains of varying sizes become distributed throughout the circumstellar medium. We show that smaller dust grains (radius <0.045 micro-meters) tend to be strongly bound to the gas and therefore follow the gas density distribution closely, with intricate finestructure due to essentially hydrodynamical instabilities at the wind-related contact discontinuity. Larger grains which are more resistant to drag forces are shown to have their own unique dust distribution, with progressive deviations from the gas morphology. Specifically, small dust grains stay entirely within the zone bound by shocked wind material. The large grains are capable of leaving the shocked wind layer, and can penetrate into the shocked or even unshocked interstellar medium. Depending on how the number of dust grains varies with grainsize, this should leave a clear imprint in infrared observations of bowshocks of red supergiants and other evolved stars.

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Comments:

Email: AllardJan.vanMarle@wis.kuleuven.be