Computing Multivalued Solutions of Pressureless Gas Dynamics by Deterministic Particle Methods

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We are interested in computing multivalued solutions of one- and two-dimensinal pressureless gas dynamics with a discontinuous potential. These equations arise in semiclassical approximations of oscillating solutions of the Schrodinger equation with the high frequency initial data. A convenient tool to derive the semiclassical limit of the Schrodinger equation is the Wigner transform, which gives, in the semiclassical limit, the Liouville (Vlasov) equation in the phase space.

In this talk, I will present a non-dissipative deterministic particle method used to capture multivalued solutions of pressureless gas dynamics. One of the major difficulty in the application of particle methods to the pressureless gas dynamics equations is recovery of the point values of the computed solution from its particle approximation. I will discuss several recovery strategies and demonstrate ability of the particle methods to achieve high resolution. I will also introduce a modified particle method, which is applied to multivalued solution computations in the presence of thin quantum barriers, that is, when the potential is discontinuous so that the Dirac delta functions appear on the right-hand side of the equations. The validity of the proposed approach will be supported by a number of numerical experiments.