Streaming instability in the dust layer of a protoplanetary disk

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Two conflicting models are proposed to explain the process that dust grains grow to become planetesimals in the protoplanetary disk.One of them is that km-sized planetesimals are formed by the self-gravitational instability in a dust layer due to dust precipitation to the midplane. The gravitational instability occurs when the dust density exceeds a critical value. However, dust layer is believed to be in turbulent state, the layer would be dissipated.The streaming instability (Johansen & Youdin 2007) due to velocity shear between gas and dusts in the radial direction in the dust settling layer is a candidate to overcome this issue since the dust density increases locally even in the turbulent state.
We study the streaming instability by using hybrid simulations, where gas and dusts are treated as fluid and particles, respectively, and the dust-to-gas mass ratio is set to be ~1.
We show the time history of the maximum dust density due to the instability in the dust layer.

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