Influence of He++ and shock geometry on interplanetary shocks in the solar wind: 2D Hybrid simulations

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Alpha particles (He+++) are the most important minor ion species in the solar wind, constituting typically about 5% of the total ion number density. When crossing an interplanetary shock protons and He++ particles are accelerated differently due to their different charge-to-mass ratio. This behavior can produce changes in the velocity distribution function (VDF) for both species in the immediate downstream region generating anisotropy in the temperature which is considered to be the energy source for various phenomena such as ion cyclotron and mirror mode waves for example. How these changes in temperature anisotropy and shock structure depend on the percentage of He++ particles and the geometry of the shock is not completely understood. In this work we perform various 2D local hybrid simulations (particle ions, massless fluid electrons) with similar characteristics (e.g., Mach number) to observed interplanetary shocks for both quasi-parallel and quasi-perpendicular geometries including self-consistently different percentages of He++ particles. We find that the change of the initial $\theta_Bn$ leads to variations of the efficiency with which particles can escape to the upstream region facilitating or not the formation of compressive fluctuations in the magnetic field that will produce increments in perpendicular temperature. The regions where both temperature anisotropy and compressive fluctuations appear tend to be more extended and reach higher values as the He+++ content in the simulations increase.