Can the magnetic field in the Orion arm inhibit the growth of instabilities in the bow shock of Betelgeuse?

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Many evolved stars travel through space at supersonic velocities, which leads to the formation of bow shocks ahead of the star where the stellar wind collides with the interstellar medium (ISM). Herschel observations of the bow shock of Î±-Orionis show that the shock is almost free of instabilities, despite being, at least in theory, subject to both Kelvin-Helmholtz and Rayleigh-Taylor instabilities. A possible explanation for the lack of instabilities lies in the presence of an interstellar magnetic field. We wish to investigate whether the magnetic field of the interstellar medium (ISM) in the Orion arm can inhibit the growth of instabilities in the bow shock of Î±-Orionis. We used the code MPI-AMRVAC to make magneto-hydrodynamic simulations of a circumstellar bow shock, using the wind parameters derived for Î±-Orionis and interstellar magnetic field strengths of B=1.4,3.0, and 5.0Î¼G, which fall within the boundaries of the observed magnetic field strength in the Orion arm of the Milky Way. Our results show that even a relatively weak magnetic field in the interstellar medium can suppress the growth of Rayleigh-Taylor and Kelvin-Helmholtz instabilities, which occur along the contact discontinuity between the shocked wind and the shocked ISM. The presence of even a weak magnetic field in the ISM effectively inhibits the growth of instabilities in the bow shock. This may explain the absence of such instabilities in the Herschel observations of Î±-Orionis.

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