bulge is older than that in the halo by 1.3±0.3 Gyr. Other possibilities can be ruled out from the analyses of the periods of RR Lyrae variables and/or other observations. Implications of this result on the formation of the Galaxy and on the age of the Universe will be discussed.

Instabilities in Cosmic Ray Dominated Shocks

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Previous studies have shown that small compressional disturbances propagating into a cosmic-ray (CR) dominated medium can be amplified by a 1D acoustic instability. If the wavelength of the disturbances is shorter than the CR pressure scale height, and if the CR pressure scale height is shorter than the diffusion length associated with sonic flow, disturbances travelling in the direction of increasing CR pressure can grow, while those travelling in the direction of decreasing CR pressure can be damped out. Here we report that, as a consequence of the 1D acoustic instability, a Rayleigh-Taylor type instability can develop in 2D flow, when the flow is perturbed along the direction parallel to the shock front. In addition to the sound waves propagating along the shock normal. Using the local WKB approximation the growth rate of the secondary instability is shown to be comparable to that of the 1D acoustic instability itself in the cases we have considered. The nonlinear development has been followed numerically with a 2D PPM hydrodynamics code that also incorporates the two-fluid CR energy equation. We show that the secondary instability may cause the precursor and post shock flows to become highly turbulent. However, neither the primary, 1D acoustic instability nor the secondary instability has a significant effect on the cosmic-ray pressure around the shock. That is because CR diffusion through the perturbations is much faster than the growth rate of the instability.

Dynamical Evolution of SNR VRO 42.05.01

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We have numerically simulated the evolution of SNR VRO 42.05.01 (G166.0+4.3) in order to understand the dynamical interaction of the SNR with the surrounding ISM. Radio