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Starburst-driven Galactic Outflows: The Suppressive Role of Cosmic Ray Halos

Galaxies with high star-formation surface densities often host large-scale outflow winds. These winds have been observed in local starbursts, such as Arp 220, M82, and NGC 253. They are also widespread at high-redshifts, where galaxies are typically more compact and have higher star-formation rates relative to their stellar mass. Outflow winds play a critical role in redistributing energy, momentum, and baryons between the interstellar medium and galactic halos, making them a key feedback mechanism that regulate galaxy evolution. Despite their importance, the driving physics behind galactic outflows and their interaction with galaxy halos is yet to be fully understood. In particular, the influence of cosmic ray (CR) halos on suppressing outflows, especially around older galaxies, has not been explored. In this study, we investigate how CR pressure gradients impact galactic outflows, determine the conditions necessary for outflow launching, and calculate their terminal velocities. We find that without CRs, stellar feedback alone can only drive outflows if the star formation rate (SFR) surface density exceeds a critical threshold. However, CRs allow this threshold to be bypassed, enabling slow outflows to be launched even at low SFR densities. Our results indicate that low-velocity outflows are more likely in young galaxies lacking substantial CR halos, while fast outflows in starburst galaxies are primarily driven by momentum injection and remain largely unaffected by CR halos. Our results demonstrate for the first time that CR halos could play a critical role in galaxy evolution, establishing them as a major component of the broader galaxy evolution framework.

Collaboration(s)

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