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A Hadronic Model of the Fermi Bubbles: Galactic Cosmic-Rays in a Breeze

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We present a self-consistent model of the Fermi Bubbles, described as a decelerating outflow of gas and non-thermal particles produced within the Galactic center region, on a $\sim$ 100 Myr timescale. Motivated by observations, we use an outflow with velocity O(100 km/s), which is slower than the velocities used in models describing the Bubbles as a more recent outburst. We take into account cosmic-ray (CR) energy losses due to proton-proton interactions, and calculate the resulting gamma-ray emission. Our model can reproduce both the spatial morphology and the spectra of the Bubbles, on a range of different scales. We find that CRs diffusing and advecting within a breeze outflow result in an approximately flat surface brightness profile of the gamma-ray emission, as observed by Fermi satellite. Finally, we apply similar outflow profiles to larger Galactocentric radii, and investigate their effects on the CR spectrum and boron-to-carbon ratio. Hardenings can appear in the spectrum, even in cases with equal CR diffusion coefficients in the disk and halo. It is postulated that this hardening effect may relate to the observed hardening feature in the CR spectrum at a rigidity of $\sim$ 200 GV.

I am also submitting an abstract to the tracks “cosmic rays” and “Galactic sources”.

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