On the energization of pickup ions downstream of the heliosheric termination shock, by comparing 0.52-55 keV observed ENA spectra to simulated ENAs inferred by proton hybrid simulations.

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As the solar system and its surrounding heliosphere move through the local interstellar medium (LISM), interstellar neutral (ISN) atoms, mostly atomic hydrogen, enter the heliosphere and undergo charge-exchange collisions with the continuously flowing solar wind (SW) protons. Newly created ions from the ISN population are advected outward with the SW under the force of the V × B electric field forming a population that is commonly known as pickup ions (PUIs). PUIs are heated in the frame of the SW with increasing distance, before reaching the termination shock (TS). At the shock, they are further heated, with a fraction of their distribution being reflected off the shock surface and undergoing additional heating. Determining the PUI distribution downstream of the Termination Shock (TS) is essential in order to understand the pressure balance and acceleration mechanisms inside the heliosheath (HS). This understanding is needed to determine the emission of Energetic Neutral Atoms from the HS because these ENAs are used to remotely sense the boundaries of our heliosphere and its interaction with the VLISM. We present here an unprecedented comparison of ~0.52–55 keV energetic neutral atom (ENA) heliosheath measurements, remotely sensed by the Interstellar Boundary Explorer (IBEX) mission and the Ion and Neutral Camera (INCA) on the Cassini mission, with modeled ENAs inferred from interstellar pickup protons that have been accelerated at the termination shock, using hybrid simulations, to assess the pickup ion energetics within the heliosheath. This is the first study to use hybrid simulations that are able to accurately model the acceleration of ions to tens of keV energies, which is essential in order to model ENA fluxes in the heliosheath, covering the full energy range observed by IBEX and CASSINI/INCA. The observed ENA intensities are an average value over the time period from 2009 to the end of 2012, along the Voyager 2 (V2) trajectory. The hybrid simulations upstream of the termination shock, where V2 crossed, are constrained by observations. We report an energy-dependent discrepancy between observed and simulated ENA fluxes, with the observed ENA fluxes being persistently higher than the simulated ones. Our analysis reveals that the termination shock may not accelerate pickup ions to sufficient energies to account for the observed ENA fluxes. We, thus, suggest that the further acceleration of these pickup ions is most likely occurring within the heliosheath, via additional physical processes like turbulence or magnetic reconnection. However, the redistribution of energy inside the heliosheath remains an open question.