The Plasma Environment at Mercury

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Mercury is the least explored terrestrial planet, and the one subjected to the highest flux of solar radiation in the heliosphere. Its highly dynamic, miniature magnetosphere contains ions from the exosphere and solar wind, and at times may allow solar wind ions to directly impact the planet's surface. Together these features create a plasma environment that shares many features with, but is nonetheless very different from, that of Earth. The first *in situ* measurements of plasma ions in the Mercury space environment were made only recently, by the Fast Imaging Plasma Spectrometer (FIPS) during the MESSENGER spacecraft's three flybys of the planet in 2008-2009 as the probe was en route to insertion into orbit about Mercury earlier this year. Here, we present analysis of flyby and early orbital mission data with novel techniques that address the particular challenges inherent in these measurements. First, spacecraft structures and sensor orientation limit the FIPS field of view and allow only partial sampling of velocity distribution functions. We use a software model of FIPS sampling in velocity space to explore these effects and recover bulk parameters under certain assumptions. Second, the low densities found in the Mercury magnetosphere result in a relatively low signal-to-noise ratio for many ions. To address this issue, we apply a kernel density spread function to guide removal of background counts according to a background-signature probability map. We then assign individual counts to particular ion species with a time-of-flight forward model, taking into account energy losses in the carbon foil and other physical behavior of ions within the instrument. Using these methods, we have derived bulk plasma properties and heavy ion composition and evaluated them in the context of the Mercury magnetosphere.