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Energetic Neutral Atoms around Mars: Latest results from the ASPERA-3 Neutral Particle Detector (NPD)

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The ASPERA-3 instrument onboard ESA Mars Express mission comprises four instruments; two energetic neutral atom (ENA) sensors and an electron and an ion spectrometer. We report observations obtained by the Neutral Particle Detector (NPD). NPD provides measurements of the ENA flux in the energy range 0.1 - 10 keV, resolving velocity and mass (H and O) with a coarse angular resolution of $5^\circ \times 30^\circ$. We focus on two observations; hydrogen atoms backscattered from the Martian upper atmosphere and hydrogen atom streams emitted from the subsolar region.

NPD sensors detected intensive fluxes of hydrogen atoms at an energy of 1 keV from the nadir direction around pericenter ($\sim$270 km). The atoms originated from the solar wind protons precipitate onto the upper atmosphere. The solar wind protons are scattered back by a cascade of charge exchange-stripping reactions at the Martian upper atmosphere. ENA images obtained by NPD indicate that the solar wind can reach large areas of the upper atmosphere depending on the solar zenith angle. They deliver mass, energy, and momentum to atmospheric atoms and mapping of these ENAs provides the global maps of mass, momentum and energy deposition of solar wind protons to the atmosphere.

NPD also observed intensive streams of hydrogen atoms of a solar wind energy emitted from the subsolar region. Since the solar wind can penetrate deeply in the atmosphere, the charge exchange is expected to occur more frequently than other places. The streams exhibit very sharp boundaries that can be associated with the charge-exchange with small scale height.