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Generation Mechanisms of Energetic Neutral Atoms in the Martian Dayside Exosphere: 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 of the Neutral Particle Detector (NPD) conducted in the dayside orbit. The observations can be interpreted as the combination of the following two sources; hydrogen atoms backscattered from the Martian upper atmosphere and hydrogen atom streams emitted from the subsolar region.

One mechanism is the backscattered ENA from the Martian exosphere. The solar wind protons precipitated into the Martian upper atmosphere are scattered back as a neutral hydrogen atoms by a cascade of charge exchange-stripping reactions. 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.

The other mechanism, the intensive streams of hydrogen atoms with a solar wind energy emitted from the subsolar region, is characterized as a very anisotropic beam generated in a very compact region. Since the solar wind can penetrate deeply in the atmosphere at the subsolar region, the charge exchange is expected to occur more frequently than other places. In addition, the streamline is highly deflected there and the ENA generation is more likely to point tangential direction. The observed streams sometimes exhibit very sharp boundaries that can be associated with the charge-exchange with small scale height.