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Plasma Acceleration and Aurora above Martian Magnetic Anomalies

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The ASPERA-3 experiment on ESAs Mars Express have made it possible to study, in detail, the acceleration processes in the nightside/eclipse of Mars. We show that there are strong similarities between accelerated/heated electrons and ions in the nightside high altitude region above Mars and the electron/ion acceleration above Terrestrial discrete aurora. We observe nearly monoenergetic downgoing electrons in conjunction with nearly monoenergetic upgoing ions. Monoenergetic counterstreaming ions and electrons is the signature of plasma acceleration in quasi-static electric fields. The discovery of localized crustal magnetizations (Acuña et al., 1999) has led to speculations about aurora also at Mars, in particular in the magnetic cusps formed by neighboring opposing magnetic poles. Observations of emissions in the 150-300 nm bands above a magnetic anomaly from Mars Express (Bertaux et al, 2005) was the first indication of aurora on Mars. We have analyzed ASPERA-3 data from over 100 Mars Express traversals of the central tail and indeed found a close correlation between crustal magnetization regions and the field-aligned acceleration of plasma. The total field-aligned acceleration based on the electron and ion acceleration, is in the kilovolt range. The total downward acceleration is expected to result in intense electron precipitation into the upper atmosphere of Mars. This is therefore evidence for discrete aurora on nightside semi-open magnetic flux tubes attached to magnetic anomalies at Mars. The difference between the Earth's polar aurora and the Martian aurora is that the latter occur closer to the equator, i.e. where the crustal magnetic field structures are located. Discrete aurora at Mars are expected to form along clefts interfacing crustal magnetization regions. However, based on our data discrete aurora is also expected to be found along a large scale, halo/oval at the circumference of the largest area of magnetic anomalies at Mars. The precipitating electron flux from the traversals is estimated to be between 1 and 50 mW/m2, well in the range of the energy fluxes

producing auroral emissions in the Earth’s upper atmosphere