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North-South asymmetries in Jupiter's FUV aurora: quasi-simultaneous observations with Hubble

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Abstract

Quasi-simultaneous observations of the northern and southern far ultraviolet (UV) auroral emissions of Jupiter have been rarely made with the Hubble Space Telescope (HST) or any other ultraviolet imager. Such observations are important to discriminate between different mechanisms responsible for the electron acceleration of the different components of the aurora such as the satellite footprints, the main « oval » or the polar emissions. The field of view of the FUV cameras (ACS and STIS) are such that only one hemisphere of Jupiter may be imaged at a time.

No HST observation was specifically designed so far to observe the various auroral features in both hemispheres at the same time. However, during the 2007-08 HST imaging campaign, observations captured both hemispheres with a viewing geometry for which the magnetic field tilt allows a good view of the auroral regions in the north and in the south. A short slew (~3 min) was imposed to the telescope during these observations to reveal, for the first time, differences between northern and southern auroral morphologies. A comparison between the last images of the first hemisphere with the first exposures of the second hemisphere minimizes differences due to mid- and long-term temporal variations. Polar projections of these FUV images obtained in both hemispheres during a given HST orbit are best suited to observe similarities and differences. An example is shown in Figure 1 where a zoom on the north and south polar regions is presented.

Different mechanisms may be been put forward to explain how auroral emissions are generated [1] and possible sources of asymmetries. A partial lack of hemispherical symmetry has been observed on Saturn's main auroral emission [2]. One possibility is related to Jupiter's internal magnetic field which is far from symmetric. Detailed analysis of the auroral footpaths of the Galilean satellites demonstrated the presence of a magnetic anomaly in the northern hemisphere [3].

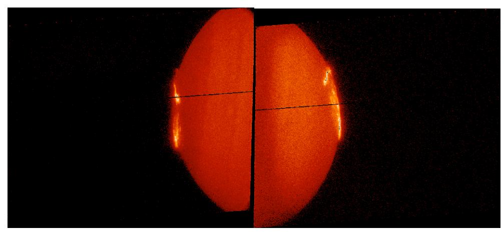

Figure 1: example of quasi-simultaneous images of Jupiters' FUV south (left) and north (right) aurora obtained from the Hubble Space Telescope.

The longitudinal N-S variations of the ionospheric field are sufficient to induce measurable variations of the emitted auroral power such as the signatures of plasma injections and satellites' footprint intensity [4]. Even though the main characteristics of these auroral features are relatively well defined by previous HST images [5,6,7], it is still unclear which physical mechanism accelerates the auroral electrons along magnetic field into the auroral zones. The large N-S asymmetry of the B field allows to discriminate between energization processes giving rise to an auroral power proportional to B, such as localized field aligned acceleration just above the ionosphere, from processes based on the auroral power approximately varying with 1/B like isotropic heating processes. The differential amount of solar EUV radiation is also a key factor which may contribute to a different ionospheric conductivity and thus an asymmetric precipitated power. Finally, differences in morphological features are also observed, including those in the auroral footprints of Io and Ganymede resulting from the interaction of the satellites and/or their own magnetosphere with the

rapidly rotating Jovian magnetospheric plasma.

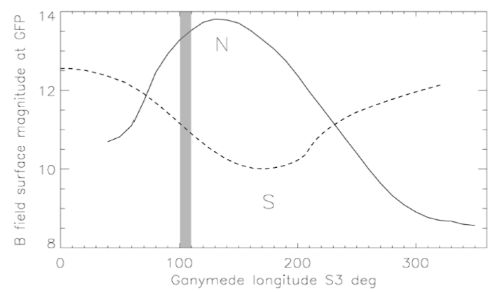

Figure 2: intensity of the ionospheric Jovian magnetic field in the north (N) and south (S) along the field line mapping to 15 R_J in the Jovian equatorial plane.

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