Observations of Saturn's aurora inside Jupiter's magnetotail

UNIVERSITY OF LEICESTER

Tom Stallard, Cordelia Brown, Henrik Melin, Mohammad N. Chowdhury, Emma Thomas, Ruoyan Wang, Jon Nichols
James O'Donoghue, JAXA **Luke Moore,** University of Boston

Here we show the measured infrared auroral brightness and ion wind velocity from August and September 2020, a period that matched in geometry to the alignment between the Sun, Jupiter and Saturn that, in 1981, resulted in clear extinction in the Saturn aurora. **We do not observe similar extinction in our data, but do observed an extended period of reduced and malformed aurora between 23-27th September.** These do not result in significant changes to the ion wind morphology. However, our observations were scheduled in sporadic bursts, rather than the originally requested 25 continuous nights, and so we cannot be sure we did not miss the auroral extinction. In order to properly test for full auroral extinction, continuous observations are needed across the cadence of the extinction (~20 days). As such, we intend to repeat this observation at the next alignment in 2040.

Scientific context and data collection

In the second half of 2020, we observed during an almost direct alignment between the Sun, Jupiter and Saturn, resulting in a once in a two-decade alignment between the magnetic cavity of Jupiter and of Saturn. A similar alignment occurred in 1981, the period leading up to the arrival of Voyager 2 at Saturn. Measurements of the radio aurora by Desch (1983) showed that there were significant drops in the auroral emission once every ~20 days, each with each drop-off lasting between 1-5 days. This cutting off of Saturn's aurora was explained as Saturn entering Jupiter's magnetotail cavity, sealing the planet's magnetic fields from the solar wind.

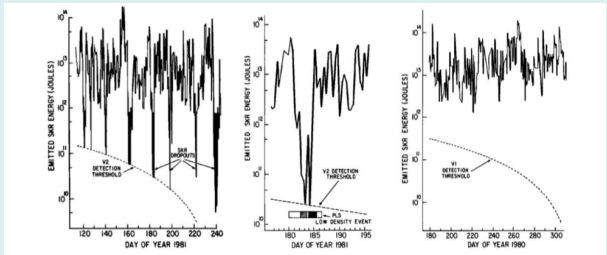
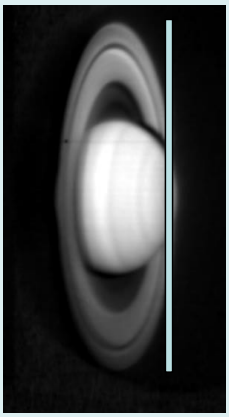
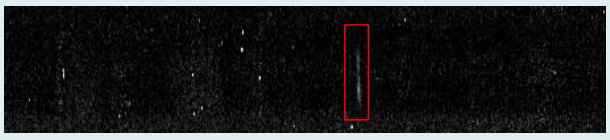


Figure 1: Survey plots of SKR energy per rotation (J/rot) showing the occurrence of SKR dropouts (shaded intervals). The left plot shows measurements by Voyager 2 on approach to Saturn, with the central plot showing one of these dimming events in detail. On the right is a comparative plot from Voyager 1, when Saturn was not immersed into Jupiter's magnetotail.

A series of observations were conducted used NASA IRTF telescope in Mauna Kea, in late summer 2020. On each night, a slit was placed east- west over the northern polar region of Saturn over ~2-hours, producing spectra in the 3.3 to 3.96 microns window.

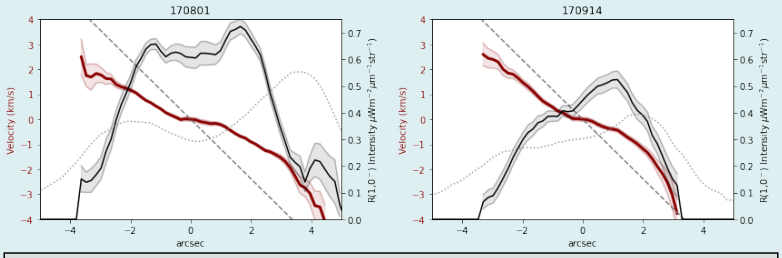
From this, the brightest lines Q(1,0-) and R(1,0-) lines could be measured. Since these fall in the wavelength range of significant methane absorption, this produces a clear signal from the H3+ aurora.





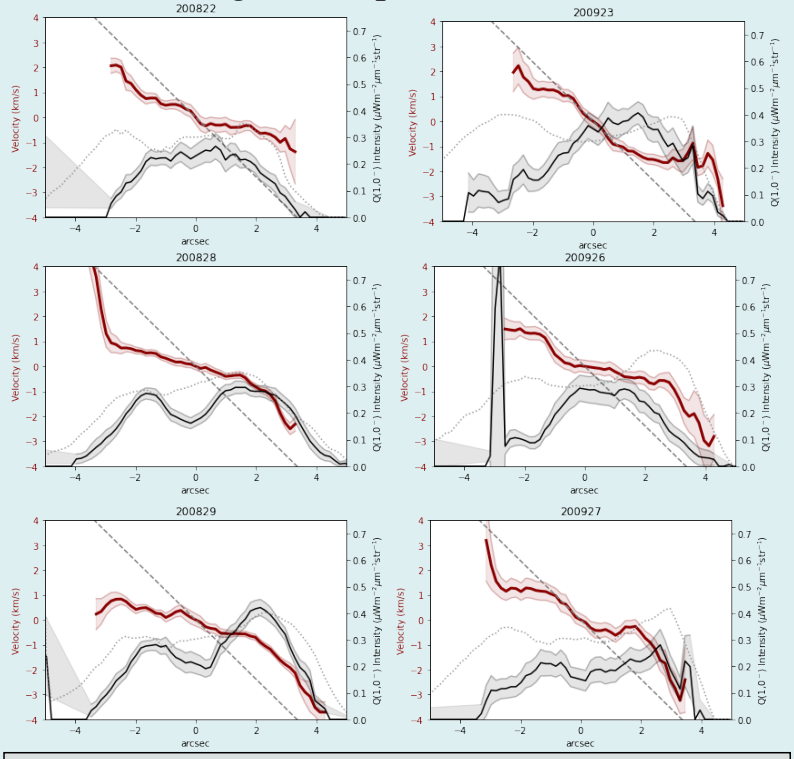
For all the plots to the right, we show the East-West cut through the planet, with the measured line-of-sight H3+ velocity in and H3+ line intensity in black red (with calculated errors for both as a lightly shaded error region) – the reflected sunlight from the lower atmosphere is shown as a dotted line.

August – September 2017



Here we show the ion brightness and velocity from August and September 2017, during the final days of Cassini provide context for these observations. The first was during a period of enhanced auroral emission, mapped in Stallard et al., 2019 using Keck – here, the auroral structures observed by Keck are smoothed out – unlike Keck, we cannot accurately measure the exact position on each individual spectral

August – September 2020



Here we show brightness and velocity from August and September 2020, during the period when Saturn was predicted to flap into and out of the magnetotail of Jupiter. The aurora is never entirely quenched, but often appears to show highly abnormal structures. In particular, the period between 23-27th September has a weak, and highly asymmetric structure. However, the ionosphere continued to display typical ion winds, suggesting that the overall mapping out into the surrounding magnetosphere has not changed. We cannot be sure whether we were able to observe a similar extinction of the aurora described in Desch (1983)