EPSC Abstracts
Vol. 6, EPSC-DPS2011-27-1, 2011
EPSC-DPS Joint Meeting 2011

The Composite Infrared Spectrometer (CIRS) on the NASA Cassini spacecraft is a dual far- and mid-IR Fourier transform spectrometer (FTS) which covers the spectral range 10 - 1400 cm^{-1} with an adjustable spectral resolution of 7.8 - 0.27 cm^{-1} unapodized [1, 2]. The CIRS detectors comprise three separate focal planes totalling 21 individual pixels: A redundant pair of far-IR thermopiles (Focal Plane 1: 10 - 650 cm^{-1}), a 1 x 10 mid-IR HgCdTe PC array (Focal Plane 3: 605 - 1119 cm^{-1}), and a 1 x 10 mid-IR HgCdTe PV array (Focal Plane 4: 1114 - 1429 cm^{-1}). CIRS is a dual-temperature FTS, since the FP3 and FP4 detector arrays are operated at ~ 76K, whereas the rest of CIRS, including the FP1 thermopiles, is maintained at ~170.0K to within ±0.1K.

Interferograms from the CIRS FP1 and FP3 detectors are contaminated by two series of prominent 0.5 Hz and 8 Hz electrical noise spikes that are caused by electrical interference due to real-time interrupt (RTI) signals from the Cassini spacecraft bus interface unit (BIU). The spikes are spaced in time during every interferogram by the RTI period of 1/8 second, and their intensities are enhanced every 2 seconds by a data transfer event. The phase of the spike pattern in each interferogram, i.e., the position of the spikes relative to the zero path difference (ZPD), depends upon the starting time of the scan, which can be controlled to some extent through selection of the interferogram length. The result in the spectrum is a series of spikes spaced by 12 cm^{-1}, corresponding to the harmonics of 0.5 Hz. The 8 Hz spike at 191.38 cm^{-1} also appears in FP1 spectra as strong harmonics at 16 Hz (382.76 cm^{-1}) and 24 Hz (574.14 cm^{-1}). Both the 0.5 Hz and 8 Hz spikes coincide with certain spectral features and can make atmospheric retrievals difficult. In addition, FP1 far-infrared interferograms are contaminated by a prominent single frequency ("sine wave") feature of unknown origin that has been observed between 18 cm^{-1} and 400 cm^{-1} during the Cassini Jupiter and Saturn encounters. There is also a harmonic series of 8.3 Hz spikes in FP3 interferograms and spectra.

The multi-parameter CIRS spike suppression algorithm described here utilizes FP1 and FP3 high fidelity empirical 0.5 Hz and 8 Hz spike waveforms ("combs") created from real deep-space data using large averages of interferograms. The algorithm matches the positions and intensities of the spike combs to the observed spikes in each interferogram and performs checks to optimize and characterize the quality of the fitting process. The FP1 sine wave is modelled by a cubic polynomial exponentially-damped cosine function. Before de-spiking, each interferogram is over-sampled by a factor of 8 and has 8 times as many points as it had originally.

The CIRS noise suppression algorithm has proven extremely successful in reducing 0.5 Hz and 8 Hz electrical noise spikes, the sine wave, and ripples < 50 cm^{-1} and > 300 cm^{-1}, in a variety of Focal Plane 1 spectra calculated from interferograms recorded at 96, 97, 224, 225, 400 and 401 RTI.

An algorithm for the suppression of electrical interference from CIRS Focal Plane 3 interferograms and spectra has been developed and is being implemented into the CIRS data calibration pipeline.

References

[1] V. Kunde *et. al.*, "Cassini Infrared Fourier Spectroscopic Investigation," in Cassini/Huygens: A Mission to the Saturnian Systems, Proc. SPIE 2803, 162 - 177 (1996).

[2] F. M. Flasar *et. al.*, *Exploring The Saturn System In The Thermal Infrared: The Composite Infrared Spectrometer*, Space Science Reviews, **115**, Issue 1-4, 169-297 (2004).