

The Gas And Ice Spectrometer/Radar (GAISR): A Millimeter/Submillimeter-Wave Multi-Functional Instrument for Cometary Jet Observations

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Abstract— An instrument prototype combining a small-particle Doppler radar and a dual-channel submillimeter-wave spectrometer is being developed to enable new observations of cometary jets and outer-moon plumes. Dubbed GAISR (Gas And Ice Spectrometer/Radar), its medium-range W-band (95 GHz) radar will operate in a frequency-modulated continuous-wave (FMCW) mode with 1 Watt of transmit power to achieve ultra-high sensitivity detection of the range and velocity distribution of 0.1-10 mm sized ice and dust particles released by jets and plumes. The radar's primary aperture also serves as an antenna for two passive heterodyne spectrometer channels at 270 and 560 GHz for detecting the abundance, temperature, and velocity of water vapor and its isotopes (including HDO), as well other major cometary volatiles. The GAISR instrument design focuses on being low mass and power instrument for compatibility with future planetary missions. This is accomplished by leveraging recent innovations in W-band signal generation using ultra-low power silicon integrated circuits, state-of-the art III-V semiconductor (GaN, InP, and GaAs) devices for signal amplification and detection, compact quasioptical duplexing, and modern low-power digital processors. A new signal processing algorithm for FMCW Doppler radar detection out to the maximum range ambiguity limit has also been developed. This talk will summarize GAISR's system design, focusing on the engineering tradeoffs in building a multi-functional flight-like instrument, and will describe very promising initial performance testing including gas cell isotopic detection and the range/Doppler mapping of rain.

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