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CASIMIR – Caltech Airborne Submillimeter Interstellar Medium Investigations Receiver

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***Abstract*— CASIMIR is a multiband, far-infared and submillimeter, high resolution, heterodyne spectrometer under development for SOFIA. It is a first generation, PI class instrument, designed for detailed, high sensitivity observations of warm (100 K) interstellar gas, both in galactic sources and in external galaxies. CASIMIR will have unprecedented sensitivity by combining the 2.5-meter SOFIA mirror with state-of-the-art superconducting mixers. These planar mixers are quasi-optically coupled to the telescope beam using twin-slot antennas, and silicon hyperhemisphere lenses with Parylene antireflection coatings. Ongoing mixer developments point to DSB noise temperature improvements of 3 *hv/k* at frequencies below 1 THz, and 6 *hv/k* above 1 THz. All CASIMIR bands use advanced Superconductor-Insulator-Superconductor (SIS) mixers fabricated with Nb/AlN/NbTiN junctions in the JPL Micro Devices Lab. Five bands are under development: 550 GHz, 750 GHz, 1000 GHz, 1250 GHz, and 1400 GHz. Observing time is maximized by having four bands available on each flight. Tunerless solid-state local oscillators are mounted on the outside of the cryostats, with injection to the mixers via mirrors and cryogenically-cooled mylar beamsplitters. The optics box supporting the two cryostats is open to the telescope cavity and contains the relay optics and calibration systems. Besides the cryostat pressure and IR-block windows, all optics are reflective and can accommodate the entire 8' telescope field of view. Bias electronics and warm IF amplifiers are mounted on the cryostats, while electronics racks contain the backend spectrometer, control electronics, and power supplies. The entire instrument is about 1.5 m long, 1 m diameter, and weighs about 550 kg. CASIMIR embodies a versatile and modular design, able to incorporate future major advances in detector, LO and spectrometer technology.**

CASIMIR will enable the study of fundamental rotational transitions of many significant hydrides and other molecules, which can provide critical tests of our understanding of interstellar chemical networks and reactions. CASIMIR will aid in understanding the chemistry of oxygen in interstellar clouds, with observations of key species, such as O, O_2, H_2O, H_2O^+, and OH. The H_2D^+ ion is of particular interest, as it is the deuterated version of H_3^+, which is believed to be responsible for driving much of the chemistry of molecular clouds. CASIMIR will allow the study of the abundance and distribution of interstellar water, which plays an important role in the energy balance of molecular clouds; nine rotational transitions of the rare $H_2^{18}O$ istopomer can be detected, including several lines near the ground state.