SuperCam: A 64 pixel superheterodyne camera

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We report on the development of *SuperCam*, a 64 pixel, superheterodyne camera designed for operation in the astrophysically important 870 µm atmospheric window. *SuperCam* will be used to answer fundamental questions about the physics and chemistry of molecular clouds in the Galaxy and their direct relation to star and planet formation. The advent of such a system will provide an order of magnitude increase in mapping speed over what is now available and revolutionize how observational astronomy is performed in this important wavelength regime.

Unlike the situation with bolometric detectors, heterodyne receiver systems are coherent, retaining information about both the amplitude and phase of the incident photon stream. From this information a high resolution spectrum of the incident light can be obtained without multiplexing. Indeed, each *SuperCam* pixel will provide 1,024 simultaneous spectral measurements. In terms of raw power, each observation made with *SuperCam* will provide ***65,536*** independent measurements of the properties of the object under study. High resolution spectroscopy can, in principle, be performed in this same wavelength regime using incoherent detectors together with frequency dispersive quasi-optical devices such as gratings and Fabry-Perot interferometers. However, the size requirement of quasi-optical devices and/or the need to scan in order to construct a spectrum make them too cumbersome or insensitive for the scientific objectives of the proposed study.

SuperCam will be constructed by stacking eight, 1x8 rows of fixed tuned, SIS mixers. The IF output of each mixer will be connected to a low-noise, broadband MMIC amplifier integrated into the mixer block. The instantaneous IF bandwidth of each pixel will be ~2 GHz, with a center frequency of 5 GHz. A spectrum of the central 500 MHz of each IF band will be provided by the array spectrometer. The spectrometer may be either an array of sixty-four, 500 MHz, 1024 lag correlator chips or sixteen, subdivided, 1 GHz wide A/D converters feeding real-time FFT digital signal processors. Each mixer will have its own electromagnet to suppress unwanted Josephson noise. Mixer, magnet, and MMIC bias of each mixer will be optimized under computer control. Local oscillator power is provided by a frequency multiplier whose output is divided between the pixels by using either a phase grating or a matrix of waveguide power dividers. The mixer array will be cooled to 4K by a closed-cycle refrigeration system. *SuperCam* will reside at the Cassegrain focus of the 10m Heinrich Hertz telescope (HHT) with a dedicated secondary and re-imaging optics. Each pixel will have a 22" diffraction limited beam on the sky.

A prototype single row of the array will be tested on the HHT in early 2006, with the first engineering run of the full array in late 2007. The array is designed and constructed so that it may be readily scaled to higher frequencies.