OBSERVATIONS OF COMET C/2009P1 (GARRADD) WITH A TUNABLE SPATIAL HETERODYNE SPECTROMTER. S. S. Hosseini[1] J. B. Corliss[1] and W. M. Harris[1], [1]University of California Davis, Department of Mechancial and Aerospace Engineering, One Shields Ave, Davis, CA 95618 (sshosseini@ucdavis.edu).

Introduction: It is now well known that comet's isotopic ratios are only partly consistent with what is observed on the Earth [1, 2]. Mass fractionation and thermal variance in the solar nebula is thought have played a role in the observed differences, but the additional complicating effects of physical evolution, overall activity state, and dynamical mixing during formation may also be important. Statistical studies over the past two decades [1,2,3,4] have led to a significant improvement in our understanding of the broad outlines of the compositional and isotopic characteristics of comets, but the sample sizes continue to remain relatively small and generally do not include significant short term temporal monitoring.

In terms of compositional class, the most commonly observed species are CN and C_2 which demonstrate a clear division of their abundance ratio into two classes [1] that are asymmetrically represented in long vs. short period comets. These species are also a benchmark for studies of isotopic ratio (^{12}C:^{13}C and N^{14}:N^{15}), which means that band-resolved measurements of these species may be used to simultaneously study both aspects of cometary composition. In this presentation we will present the initial results from an instrument designed for high sensitivity measurements of molecular band emission from comets at a resolving power sufficient to monitor isotopic ratios in addition to bulk production.

Instrumentation: New observations will be performed using a tunable spatial heterodyne spectrometer (TSHS), which is a form of self-scanning interferometer [5]. A TSHS instrument takes an input collimated beam and splits it into symmetric orders with a grating, circulates them antisymmetrically with a set of pilot mirrors, and then recombines them a second time, after which they exist the instrument. The pilot mirrors are rotated into an angle such that, for a specific wavelength (hereafter the 'heterodyne wavelength'), the two beams emerge with their wavefronts parallel. For all other wavelengths, dispersion in the grating rotates the wavefronts and they interfere to form a linear pattern of fringes with a frequency related to their separation from the heterodyne condition. A Fourier transform of the pattern recovers the original spectrum. The primary advantage of TSHS comes from three factors. First, it is able to simultaneously provide high resolving power (R) *and* a wide field of view (FOV), giving the instrument exceptional sensitivity to extended targets. Second, the FOV is linearly scalable with the aperture of a telescope without losing sensitivity. Third, while the intrinsic sampled bandpass (defined by the number of fringes that can be imaged at a detector) is limited, a simple rotation of the pilot mirrors can be used to look at narrow to intermediate bandpasses over a range from 300 to 700 nm. The TSHS for this project is located at the fixed focal plane of the 0.6m Coudé Auxiliary Telescope (CAT) on Mt. Hamilton. It has been configured to simultaneously sample ~10 nm bandpass at R=48000 over a 39" x 39" FOV that is well matched to observations of comets. With this configuration, the TSHS can provide étendue comparable to that obtained with the Keck-HIRES instrument, with the additional opportunity to obtain far larger amounts of observing time.

Observations: The TSHS has been incorporated into the CAT focal plane (Figure 1) as of February/March 2012 and is undergoing initial science observations targeting comet C/2009P1 (Garradd). The TSHS is used in two tuning positions that track the CN (388 nm) and C_2 (472 nm) bands. Short tuning times allow both species to be sampled each night. Garradd is available at an airmass less than 2 for times ranging from 8 hours (February, 2012) to 4 hours (May, 2012) at a magnitude between 7 and 9. We will report on the results of these observations, including an analysis of instrument stability and performance.

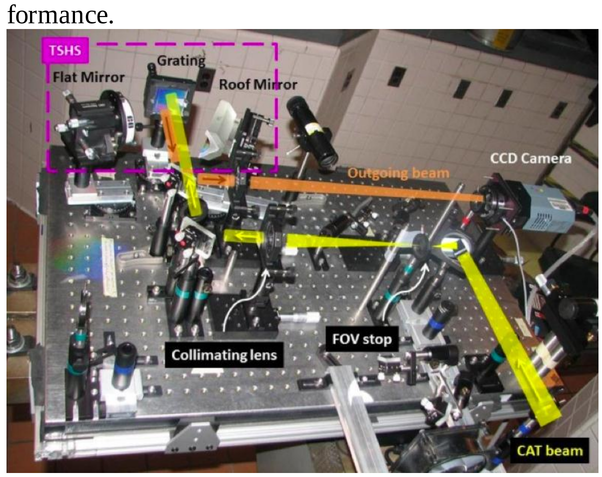

Figure 1. The TSHS at the CAT telescope.

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