DIRECT DETECTION SUBMILLIMETER SPECTROSCOPY AT CORNELL UNIVERSITY

Stacey, G.J., Hailey-Dunsheath, S., Nikola, T.
, Oberst, T., Parshley, S.C.
Department of Astronomy, Cornell University, Ithaca, NY 14853

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1. (a) Gordon Stacey
   Department of Astronomy
   Cornell University
   Ithaca, NY
   14853 USA
   gjs12@cornell.edu
   (b) 607-255-5900
   (c) 607-255-5875

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3. (a) S-J/B2

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We present an overview of the direct detection submillimeter spectroscopy that is the focus of our research group at Cornell University. Direct detection spectrometers provide an important complement to heterodyne receivers in the submillimeter windows. For velocity resolved profiles of Galactic sources, heterodyne systems are the receivers of choice. However, for sources with line widths that are well matched to their resolving power (e.g. external galaxies), direct detection spectrometers can provide superior sensitivity. They also can deliver very wide spectral bandwidths and/or widefield spectrtoscopic imaging. At Cornell, we have constructed two direct detection spectrometers, the South Pole Imaging Fabry-Perot Interferometer (SPIFI), and the redshift (z) and Early Universe Spectrometer (ZEUS).

SPIFI is an imaging Fabry-Perot that has been deployed on both the 15 m JCMT on Mauna Kea, and the 1.7 AST/RO telescope at the South Pole. Our results with SPIFI include mapping of the 370 um [CI] and CO(7-6) lines from a several star-forming galaxies (e.g. NGC 253 and the Antenna Galaxy), and the Galactic Center. These lines trace the physical conditions of the warm neutral ISM, and are important coolants for this component. Among the more interesting results at JCMT is the discovery that much of the molecular ISM in the starburst nucleus of NGC 253 is heated by cosmic rays. SPIFI wintered over on the AST/RO telescope during the 2005 season, during which we detected the 205 um [NII] line from the Carina Nebula. The [NII] line is an important coolant for the diffuse ionized ISM, and (together with the 122 um [NII] line) is an excellent probe of gas density. This is the first (or nearly the first) detection of this line from the ground, and demonstrates the utility of Antarctic sites for THz spectroscopy.

ZEUS is a submillimeter grating spectrometer that had its first engineering run at the JCMT in March of 2005. Since it is a spectral multiplexer, ZEUS is optimized for detection of faint broad lines from point sources such as distant galaxies. Our primary goal with ZEUS is to detect the 158 um [CII] fine structure line emission from distant submillimeter bright galaxies. This line is typically the strongest cooling line from atomic clouds and photodissociation regions, and traces the strength of the ambient interstellar radiation field in galaxies. ZEUS can detect this line from star forming galaxies at redshifts from 1 to 4 as it is redshifted into the 350, 450, 620 and 850 um telluric windows. We hope to have science runs with ZEUS at the CSO and SMT in early 2006.

We finish our talk with a discussion of the prospects for a 25 m class submillimeter telescope on a high peak near the ALMA site.

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