FarIR Astronomy with the CO N^+ Deuterium Observations Receiver (CONDOR)

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To this data there are very few astronomical observations at THz frequencies (1-10 THz,300μm-30μm) at high spectral resolution. This is partly due to the poor (Earth) atmospheric transmission at these frequencies, partly due to the difficulties in building heterodyne receivers above 1 THz. However, this frequency regime harbors a multitude of astronomically interesting molecular and ionic transitions. The excitation energy of these lines mostly lie between a few tens to a few hundred Kelvin, low enough to be excited in the warm to hot interstellar medium. Therefore high spectral resolution observations at THz frequencies provide an ideal tool to study the chemical and kinematic properties of the ISM, e.g. in star forming regions.

Currently, there are only two operating THz heterodyne receivers in use, one on the Receiver Lab Telescope (RLT), the other is CONDOR, our CO N^+ Deuterium Observations Receiver. CONDOR has successfully obtained first light observations in Nov 2005 on APEX. A modified CONDOR will be the low frequency extension of the German REceiver At THz-frequencies (GREAT), which has been selected as one of the two first flight instruments on the Stratospheric Observatory For Infrared Astronomy (SOFIA).

CONDOR was built with a focus on studying star formation processes. It covers a frequency range of 1.25 to 1.53 THz (240μm - 196μm) and can simultaneously observe 0.8 GHz (about 160 km/s), hopefully soon 2 GHz (400km/s). As it is a front end receiver only, the spectral resolution depends on the backend used, but usually lies around 100 kHz (0.02 km/s). Technically CONDOR resembles standard submillimeter heterodyne receivers. However, there are two particular challenges to be overcome when working at the THz range: As the standard SIS mixers do not work at those high frequencies, we use Hot Electron Bolometer (HEB) fabricated in-house (Munoz et al. 2004). Secondly, because there is little Local Oscillator (LO) power available at THz frequencies, we employed a Martin Puplett interferometer, in order to overlay the LO with the sky signal with very small losses. CONDOR has a DSB receiver temperature of 1500 K, which is among the best reached for THz receivers.

The name CONDOR suggests, which molecules/ions we are most interested in observing: the high-J CO transition lines (J 11-10, 12-11, 13-12), the fine structure line of N^+ at 205μm and the ground transition of p-H_2D^+. The high-J CO lines trace hot (E_{up} $\sim$500 K), dense (ρ_{crit} $\sim$$10^7$$cm^{-3}$) molecular gas, as it can be found in high mass star forming regions. The N^+ emission at 205 μm is the third strongest emission line in the Milky Way in the range of 104 to 4400 μm ($\sim$ 3 - 0.1 THz) (Fixsen, Bennett, & Mather 1999). The emission probably stems from the Warm Ionized Medium as well as from HII regions. In cold molecular environment H_2D^+ is the key molecule for deuterium chemistry, as all deuterated molecules are formed via H_2D^+. In addition,it is one of the few molecules not to freeze out and it is therefore one of the last remaining molecular tracers in the cold ISM.

At the conference, we will show a poster explaining the science goals of CONDOR. Volgenau's poster (see separate abstract) will present the first results obtained by CONDOR during our observations at APEX in Nov 2005. If space permits, there will also be a poster with the technical details of CONDOR.

References:

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