FUTURE CO OBSERVATIONS WITH THE JCMT

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1. Introduction

The JCMT is a multi-national 15m diameter telescope located on Mauna Kea and is equipped with a suite of four facility heterodyne and continuum receivers located at Cassegrain and Nasmyth foci for observations over the 2.0mm (150GHz) to 0.35mm (860GHz) atmospheric windows. The receivers are all on-line and remotely selectable by a tertiary mirror. The telescope pointing accuracy is better than 1.5″ in each axis and the surface accuracy is better than 25μm. The JCMT is operated in two shifts, each of eight hours per night and 24 hour operator coverage is provided for extended daytime observing. Facility astronomers are available for user support. A primary astronomical goal for the JCMT is to be able to cover all CO transitions (including isotopic species) observable from Mauna Kea. There is a healthy programme of facility developments to the tune of $800k a year and this paper discusses those developments which will have an impact on CO observing with the JCMT over the next decade.

2. New Instruments

There are two new heterodyne instruments about to be delivered to the JCMT. In 1996 we expect to receive the new 345GHz facility instrument (RxB3) from HIA (Ottawa). This will provide dual polarization capability from 330-360 GHz and has an IF bandwidth in excess of 1 GHz. It will have a cooled single-sideband filter and a receiver temperature <100K at 345GHz using SRON/University of Groningen (RUG) Nb junctions. Laboratory tests have already achieved reproducible values of noise temperatures <80K. It will come equipped for remote operation, including tuning.

MRAO are producing a dual polarization 'wideband' receiver (RxW) to work in the 440-500GHz and 660-690GHz bands. The goals are to have

receiver temperatures <200 K at 460GHz and 500K at 670GHz. Laboratory tests have already achieved noise temperatures of <60K at 460GHz using SRON/RUG junctions. The IF bandwidth will also be around 1.5GHz and like RxB3 this receiver will also be fully equipped for remote operation. It is provided with a closed cycle cooler.

3. The Upgrade Programme

As part of the facility developments we have introduced a programme to continually upgrade our receivers in order to remain competitive. In pursuit of this, R&D on SIS junction fabrication has been supported at SRON/RUG and this has resulted in the provision of excellent junctions for all the new facility receivers. R&D activity on wide-band and tunerless mixer development is also supported at MRAO and HIA.

We also intend to undertake a fast upgrade for our current 230GHz receiver by utilizing the existing 345GHz receiver (when it is replaced by RxB3) which will be fitted with a new 230GHz mixer using an NRAO designed block and a UVa SIS junction. This will provide single pixel, single polarization coverage from 210 to 280GHz with a target of 50K DSB across the entire frequency range and with a 1.5GHz bandwidth giving an instantaneous velocity coverage of around 1900 km/sec. It will be equipped for fully remote operation and the upgrade will start at HIA in early 1996.

Our current 460GHz receiver will be upgraded to an 800-900 GHz receiver (RxE) following its replacement by RxW. This will be another fast track upgrade and will use either SRON/RUG Nb junctions or PbBi junctions from the University of Kent. It will be a single pixel, single polarization receiver fitted with a cooled single-sideband filter and a 1.5GHz bandwidth IF. It will not be remotely operated or remotely tuned and is being upgraded by the builders at the Rutherford Appleton Laboratory in the UK.

4. The 345 GHz Array

The 345 GHz window is capable of providing an abundance of riches of scientific excellence, being available for most of the time on Mauna Kea and being well matched to the high surface accuracy of the JCMT. A particularly exciting development is the provision of a 345GHz focal plane array and associated backend.

There are a number of goals in the design of the array: it should never become background limited; it will be provided with a cooled image sideband rejection filter; the mixers will be 80K or less and in order to remain competitive against single channel devices it must have very low optical losses. The design calls for a 32 pixel array, operated in a dual polarization

mode of two 4×4 array cameras, each with a field of view of $70 \times 70''$. The receiver will be mounted on one of the Nasmyth platforms adjacent to the new correlator and hence dramatically simplify the IF system. At present it is not determined whether two B-band cameras will be provided or, alternatively, a single camera at B-band and, by having the second camera at C or D- band, thereby introducing a dual frequency mapping capability. The cameras are mounted in individual cryostats and are therefore interchangeable as scientific needs dictate.

The correlator is a 32-bank spectrometer serving both cameras. It will have an IF centred at 6GHz and will operate in three modes. These are: extragalactic with 1750 km/s velocity coverage at 5.5 km/s resolution; star formation with 880 km/s at 1.4 km/s and high resolution with 220 km/s at 0.2 km/s. These figures are for a sixteen-bank spectrometer (the day 1 provision) being fed by a single camera. The next sixteen banks will provide higher spectral resolution by almost a factor of two.

The spectrometer will be designed around ultra-fast (4 Gsamples/s) ADCs with instantaneous 2GHz bandwidth sampling. There is a goal for cross-correlation capability. The chip design is being undertaken with Brian Von Herzen and is based on a development of the CSO MkI chip. The use of field programmable gate arrays forms a novel aspect of the chip development.

5. Conclusion

The JCMT looks towards an exciting future. As well as the heterodyne developments, there is the eagerly awaited and soon-to-be-installed facility array bolometer (SCUBA) which will provide spectacular sensitivity continuum point-source and mapping capability. The facility developments are also looking towards improving the surface accuracy, perhaps to 15μm, to make high frequency observations even more efficient. The move towards sub-arcsecond imaging provided by links with the SMA promises to be a very exciting prospect, while flexible scheduling should enable the high frequency science to be delivered and the full potential of the facility to be maximised.

6. Acknowledgements

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