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ABSTRACT

We have acquired spatial-spectral datacubes of astronomical objects using the Livermore visible-band imaging Fourier transform spectrometer at Apache Point Observatory. Each raw datacube contains hundreds of thousands of spectral interferograms. We present in-progress demonstrations of these observations.

Keywords: Imaging spectroscopy, multi-object spectroscopy, Fourier transform spectroscopy

1. OBSERVING HISTORY

In this conference proceeding, Wishnow et al.[1] present an overview of this instrument and the field of astronomical imaging Fourier transform spectroscopy (IFTS). This paper corresponds to a poster at this meeting featuring a gallery of data from this collaboration's IFTS. In the past four years, we have made nine astronomical observing runs, all in the visible band, to develop the technique of IFTS for astronomy. We presented results from our first working instrument[2] to the Next Generation Space Telescope (NGST) Science and Technology Exposition. The second instrument contains a Bomem interferometer built for a Canadian Space Agency benchtop proof of concept. We extensively modified it for use on a telescope and have observed on the Cassegrain port on the one-meter Nickel telescope at Lick Observatory and on the Nasmyth mount on the 3.5-meter ARC telescope at Apache Point Observatory (APO). We present here results from the four productive runs at APO. Each run featured several improvements to the instrument which in turn led to improvements in data quality and observing technique.

2. OBSERVATIONS AND DATA

Since the days of the NGST demonstration, our goal has been to obtain data that incrementally demonstrate increased functionality. In the lab, we are also carefully developing techniques for obtaining the most information from the existing datasets. One of the challenges is presenting the data in a comprehensible and comprehensive form. For the published proceedings, we will present most of our data in simple black and white line drawings. For the poster, we are showing more data that relies on good color reproductions.

The grids of spectra we present here are typically samples of individual pixels from a subregion of our original 512×512 0.28 arcsec/pixel image. For fainter objects, we co-add several neighboring pixels to increase the signal to noise in any spectrum. Typical seeing is approximately 4 pixels FWHM, so co-adding is a feasible option. In any case, these bright objects with emission lines demonstrate the potential of a broadband imaging spectrometer.

The data shown in Figures 1-3 in this paper were obtained as described in Table 1.

Table 1: Observing data for objects presented in this paper

Object	Observation date	Total observing time	Number of Interferometric samples	Spectral Order	Passband (Angstroms)	Spectral resolution near H alpha (Angstroms)
M57 Ring Nebula	4 Jun 2001	3000s	600	2	4000-6700	20
M42 Orion Nebula	2 Dec 2001	1024s	1024	1	4000-6700	20
MS0906+11	19 Mar 2002	9600s	32	2	4000-6700	350

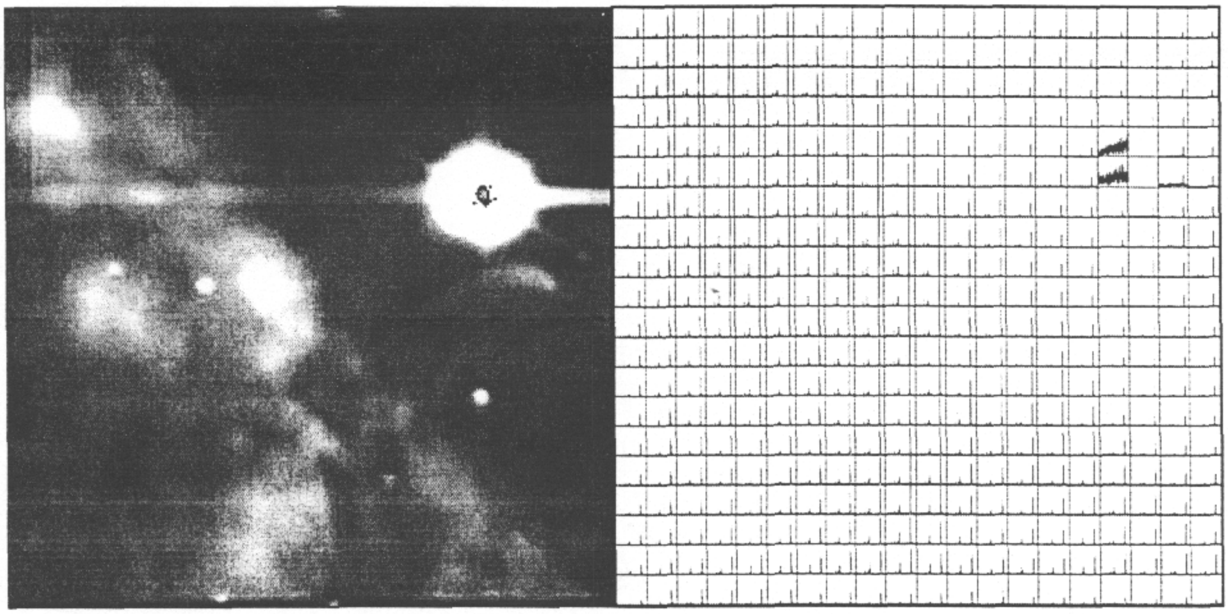

Figure 1. a. 256×256 pixel subimage and b. spectra for 400 of those pixels in one quarter of our datacube of the Orion nebula. The x-axis is roughly 4000 to 7000 Angstroms. You can see [OIII] in the center and Hα to the right in most spectra. All the spectra have the same vertical scale of arbitrary units. The noise spectra correspond to the saturated star. Spectra on the "bar", a region of different ionization characteristics, are clearly seen extending from lower right to upper left.

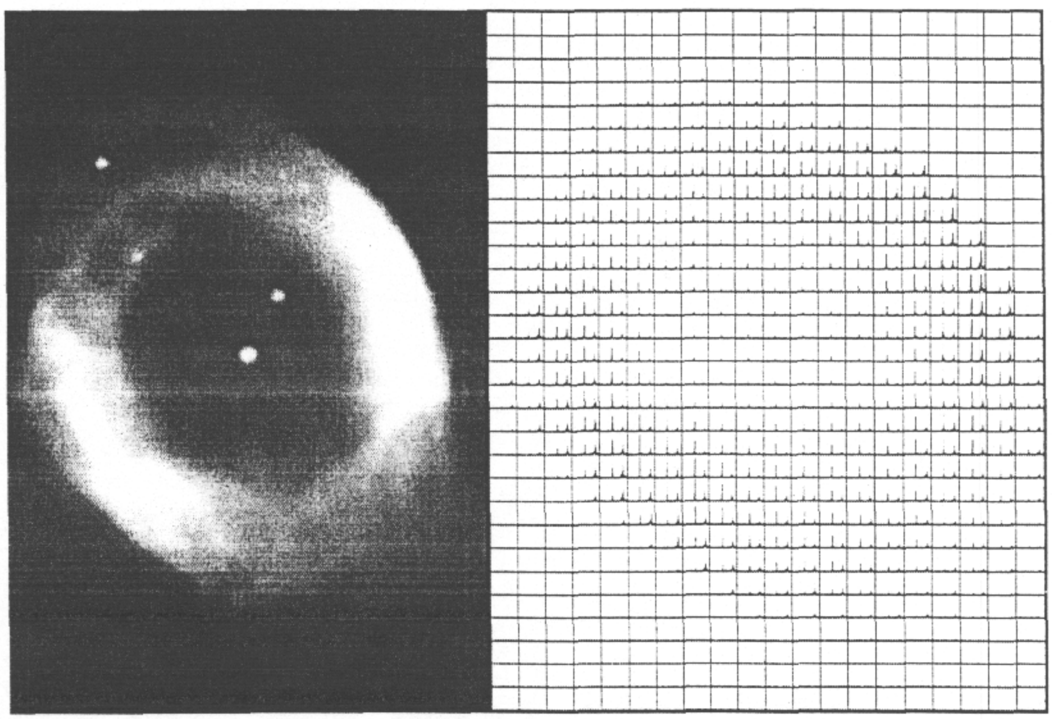

Figure 2. a. 256×384 pixel subimage and b. spectra for 600 of those pixels in 3/8 of our datacube of the Ring nebula. The x-axis is roughly 4000 to 7000 Angstroms. You can see [OIII] in the center and Hα to the right in most spectra. All the spectra have the same vertical scale of arbitrary units.

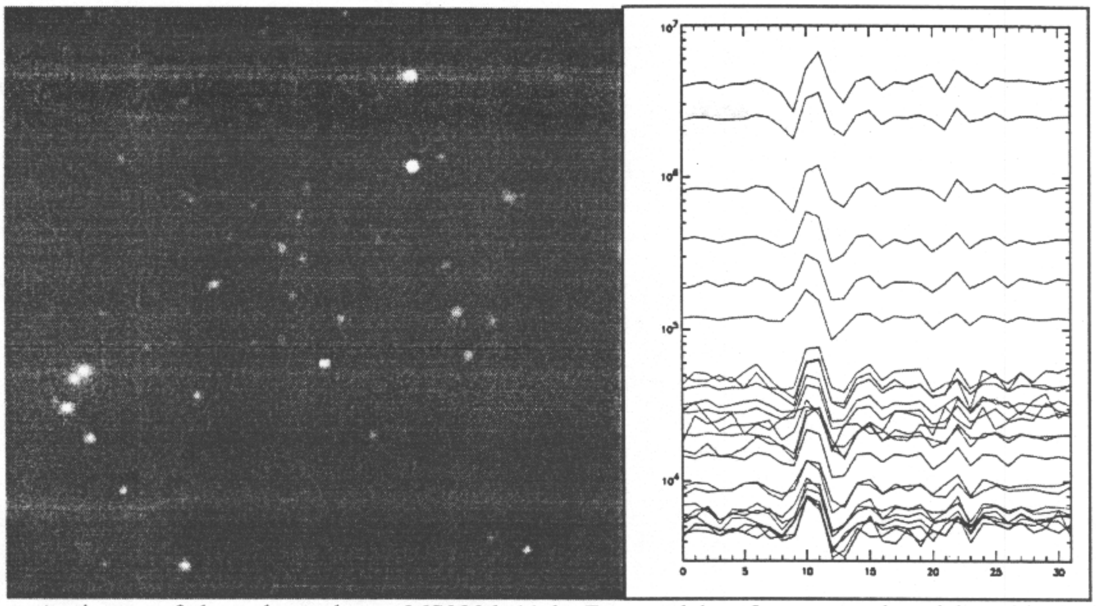

Figure 3. a. An image of the galaxy cluster MS0906+11 b. Extracted interferograms plotted logarithmically for the brightest objects detected, extending over three orders of magnitude. The observation is intended as a test of IFTS for photometric redshift studies. The spectral resolution of this observation is computed to be 350 Angstroms, which corresponds to medium band photometry. The interferograms have yet to be corrected so that they can be transformed into low-resolution spectra. It is not yet clear whether these data should be analyzed by their transformed spectra or in interferometric space.

3. CURRENT STATUS

To better understand the contributions from the various sources of error, all these datasets are still being checked in more detail for the effects of bad pixels, cosmic rays, electronic noise, dark current, image registration, scattered light, seeing, non-photometric common mode variation, tracking errors, periodic interferometer sampling errors, etc. We are also in the process of developing user-friendly methods for flux and frequency calibration. Models have shown[3,4] that the best fields for observation with IFTS are those with extended or numerous sources, for the multiplex advantage, and those objects whose spectra have strong features such as emission lines or spectral breaks.

4. ACKNOWLEDGEMENTS

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5. REFERENCES

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