Brackett Gamma Imaging of the Nucleus of M83

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Abstract

The gas-rich nucleus of the barred spiral galaxy, M83, is a hotbed of star formation, with a total infrared luminosity of 4 x 10^{9} L_{o}. We have observed the nucleus of M83 with the near-infrared spectrometer, NIRSPEC, on Keck 2 to obtain high resolution Br recombination line spectra of the nucleus. Simultaneous imaging with the SCAM camera in a broadband K filter shows the position of the slit on the near-infrared galaxy. This allows us to map the nucleus with a continuum reference. The SCAM image shows a bright peak at the nucleus and a complex semi-circular arc of emission to the southwest. We stepped the 0.5" x 24" length slit in small declination increments to map a 20" x 20" region just west of the nucleus. Individual spectra were used to form a RA-Dec-lambda cube and an integrated intensity map of Br .

A total of 1.1 x 10^{-16} W m^{-2} of Br emission is detected in the map, in good agreement with previous low resolution observations [4]. This is not corrected for extinction within the molecular clouds in M83 or to the nebulae themselves and is therefore a lower limit to the true Br flux. Extinction is estimated to be at least a magnitude in the near-IR as measured in larger (4") beams [4]. The bulk of the Br emission extends along the northern portion of the near-IR continuum semi-circle. Twenty percent of the total Br emission comes from a single 3" (FWHM) source located 4.5" west of the near-IR nucleus.

The complementary NIRSPEC Br data we have obtained will eventually allow us to evaluate the near-IR extinction on subarcsecond sizescales and obtain an extinction-corrected estimate of the Lyman continuum rate and therefore the number of ionizing stars.

[1] Meier, D. private communication
[2] Sakamoto, K., et al. 2004, ApJ, 616, L23
[3] Thatte, N. Tecza, M. & Genzel, R. 2000, A&A, 364, L47
[4] Turner, J., Ho, P. & Beck, S. 1987, ApJ, 313, 644
[5] Turner, J. & Ho, P. 1994, ApJ, 421, 122

The large background image is a combination of Br in green, K-band in red, and CO(1-0) in blue.

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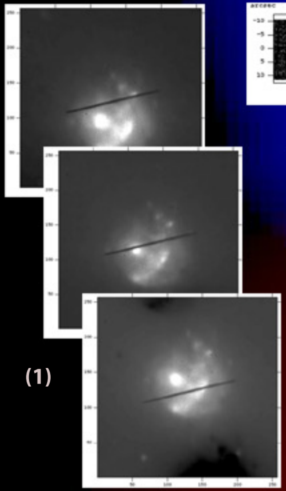

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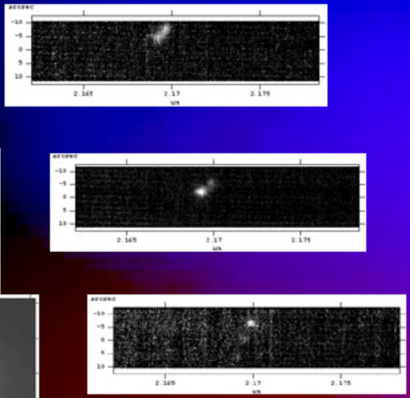

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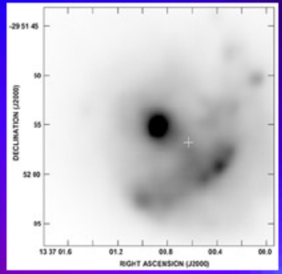

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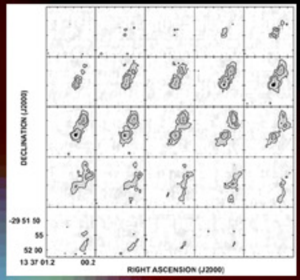

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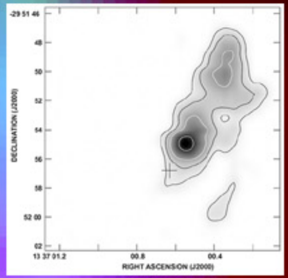


Building a Br Image From Stepped NIRSPEC Observations

By stepping the NIRSPEC slit across the object we obtain the spatial coverage needed to produce a Br map. For each exposure a slit camera, SCAM, image (1) and echelle spectrum, SPEC, (2) are obtained. The multiple SCAM images are combined to produce a K-band map (3). Observations of A type stars, bracketing a series of stepped exposures, give us an initial flux calibration for our SPEC images. Gaussian sources on the SCAM images are measured to track changes in seeing and atmospheric transmission between calibration star observations. Thus, we can adjust the spectrum calibration for all the SPEC images between calibration star measurements.

The on-object slit positions from the SCAM images are used to position the individual SPEC images in a RA-Dec-lambda cube. A 2um continuum image, made from the offline cube channels, is compared to the K-band image as a final check on the spatial positioning of SPEC images in the cube. After baselining the cube, we are left with a Br cube (4), from which a Br map was made (5). Our Br mapping primarily covers the western side of the nucleus. While we have less coverage on the eastern side, the lack of thermal radio continuum to the east of the K-band nucleus would seem to indicate that Br will also be absent.

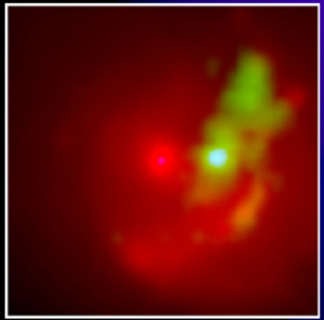
Comparisons to Star Formation Tracers

In general, the Br line emission lies along the western K-band emission arc; although Br emisson anti-correlates with the K-band emission along the arc (6). The most conspicuous aspects of the two images are the well-separated, by 4.5", Br and K-band peaks. The K-band peak is 3.5" from the isphotal center (cross in 3,5) found by Thatte [3]. The Br peak is only 2" away. Perhaps the Br peak is the unseen conterpart to the 'double' nucleus in M83 [2,3].

The Br emission is coincident with the CO(1-0) emission [1] as we might expect: star formation is located at the site of the building material, molecular gas (7). But, there is no major feature correlation between the two.

In a comparison to 6 cm and 2 cm radio emission [5], Br correlates well with both these thermal free-free emission tracers (8,9). Apparently the normal source for 2 um thermal continuum emission, dust, is absent from the regions with the strongest Br emission.

(6)



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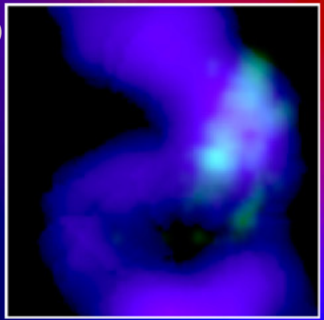

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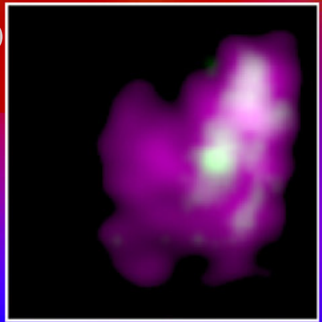

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