REVOLUTION IN ASTRONOMY WITH ALMA: THE THIRD YEAR
ASP Conference Series, Vol. 499
Daisuke Iono, Ken'ichi Tatematsu, Al Wootten, Leonardo Testi, eds.

Circumnuclear Molecular Gas Reservoirs in Mrk 590, a Seyfert Galaxy in Transition

J. Y. Koay,[1] M. Vestergaard,[1,2] V. Casasola,[3,4] and B. M. Peterson[5]

[1]*Dark Cosmology Centre, University of Copenhagen, Denmark*
[2]*Steward Observatory, University of Arizona, USA*
[3]*INAF - Osservatorio Astrofisico di Arcetri, Italy*
[4]*INAF - Istituto di Radioastronomia & Italian ALMA Regional Centre, Italy*
[5]*Department of Astronomy, The Ohio State University, USA*

Abstract. We present preliminary results from the first interferometric observations of the distribution of molecular gas in the central few kiloparsecs of Mrk 590, which in recent years has surprisingly transitioned from a Seyfert 1 to a Seyfert 1.9 or 2 galaxy.

1. Introduction: Type Transitioning of Mrk 590

Sometime between 2006 and 2012, the broad Hβ emission line of Mrk 590 (Fig. 1, left), once classified as a bona-fide Seyfert 1 galaxy, has completely disappeared (Denney et al. 2014). The optical-UV continuum emission has decreased to the point where it can be fully accounted for by stellar population models of the host galaxy. As such, Mrk 590 would now be classified as a Seyfert 1.9 or 2, which goes against the prevailing scheme of AGN classification and unification where the presence of broad emission lines depends only on source orientation. This type-transitioning could be due to a lack of nuclear gas to fuel the central engine. If the gas in the very center is not replenished, the accretion activity ceases, and the black hole is starved and turns quiescent. We have obtained ALMA Cycle 2 observations of the ^{12}CO(3–2) line emission to determine the amount of nuclear molecular gas available and the gas transport mechanisms (or lack thereof) responsible for feeding its central black hole.

2. Preliminary Results

The integrated flux map of the ^{12}CO(3–2) line obtained with ALMA shows an irregular ring-like structure in the central 2 kpc ($\sim 4''$, Fig. 1, right). The ALMA 343 GHz continuum emission spatially coincides with the unresolved 8.4 GHz radio source (Kinney et al. 2001) where the AGN is most likely located. However, there is no detection of any overlapping ^{12}CO(3–2) emission in this central region down to an integrated flux density of $\sim$ 0.1 Jy km s^{-1}. This constrains the molecular gas mass to no more than 4.7×10^5 M$_\odot$ within the central 120 pc of Mrk 590, assuming a conversion factor of $\alpha_{\rm CO} = 0.8\,{\rm M}_\odot\,({\rm K\,km\,s^{-1}\,pc^2})^{-1}$ (Sandstrom et al. 2013) and a line brightness ratio of $L'_{\rm CO(3-2)}/L'_{\rm CO(1-0)} = 0.6$ as seen in star-forming galaxies (Carilli & Walter 2013). This is sufficient to support the AGN activity for 3.8×10^5 years at Eddington accretion rates, and longer for lower rates of accretion, for a black hole mass of 4.75×10^7 M$_\odot$ (Peterson et al. 2004) and a 10% mass-to-energy conversion efficiency.

Approximately 20% of the molecular gas mass in the ring lies in a bright clump centered $\sim$ 250 pc West of the AGN, the most likely source of replenishment of gas into the central 120 pc. If so, it is enough to fuel the AGN for a further 1.2×10^6 years. We are in the process of

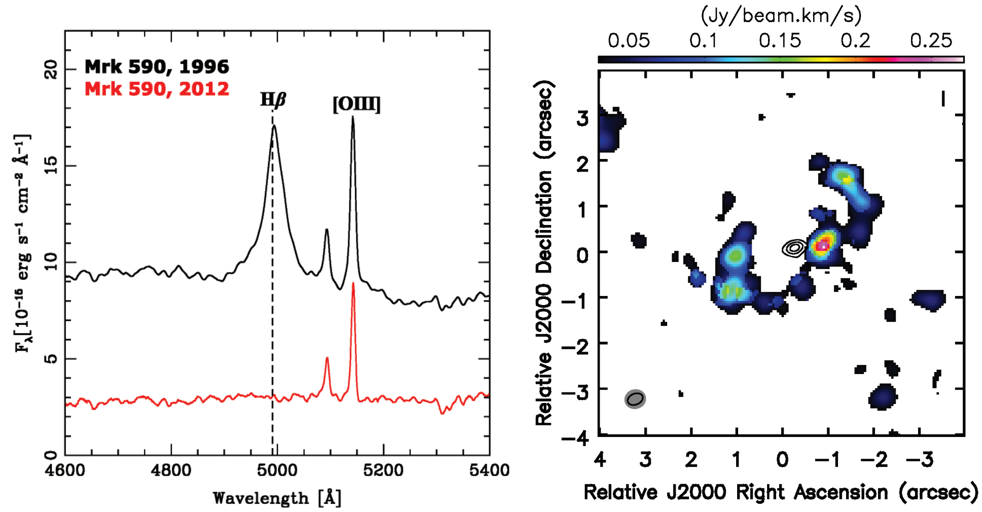

Figure 1. *Left:* The broad Hβ line emission observed in 1996 (Peterson et al. 1998) had disappeared when re-observed in 2012 at the MDM observatory (no host subtraction). *Right:* Map of the integrated fluxes of the ^{12}CO(3–2) line in the inner 8 kpc of Mrk 590, obtained using natural weighting (uv-taper: 300kλ, FWHM beam size: $0.''46 \times 0.''44$, no primary beam corrections). Flux clipping was performed to set pixels with values $< 3\sigma$ to zero, where $1\sigma \sim 0.5$ mJy beam^{-1} per 20 km s^{-1} channel. Black contours show the continuum image (Briggs weighting, robustness: 0.5; beam size: $0.''34 \times 0.''23$; contour levels: 5σ, 10σ, 15σ; $1\sigma \sim 0.04$ mJy beam^{-1}).

modeling the gas kinematics to better understand the mechanisms responsible for the transport of gas from kpc to 100 pc scales, and to search for non-rotational gas components.

Acknowledgments. JYK is supported by grant VKR023371 from Villumfonden. The Dark Cosmology Centre is funded by the Danish National Research Foundation. We used the ALMA data: ADS/JAO.ALMA#[2013.1.00534.S]. Travel to the Nordic ARC was made possible through the MARCUs RadioNet3 funding from the European Commission Seventh Framework Programme (FP/2007-2013) under grant agreement No 283393. We thank the staff of the Nordic and Italian ARCs for their assistance.

References

Sandstrom, K. M., et al. 2013, ApJ, 777, 5
Carilli, C. L., & Walter, F. 2013, ARA&A, 51, 105
Denney, K. D., et al. 2014, ApJ, 796, 134
Kinney, A. L., et al. 2001, ApJ, 537,152
Peterson, B. M., et al. 1998, ApJ, 501, 82
Peterson, B. M., et al. 2004, ApJ, 613, 682