

# The changing-look AGN Mrk 590: radio variability, accretion flow, and gas fueling

*(Image Credits: HST Legacy Archive)*



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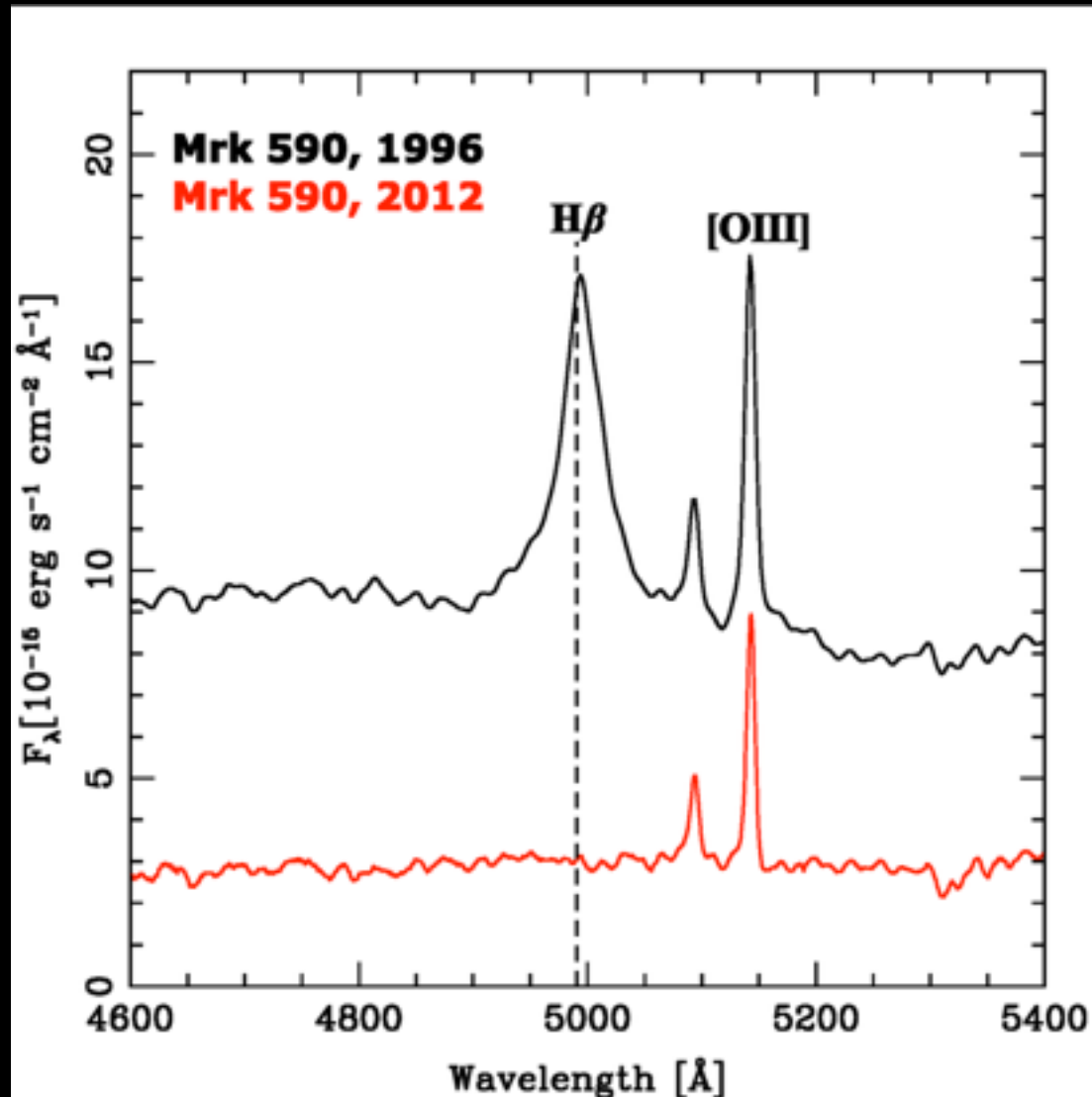
#eXtremeAGN at UVI (12/07/17)



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天文及天文物理研究所

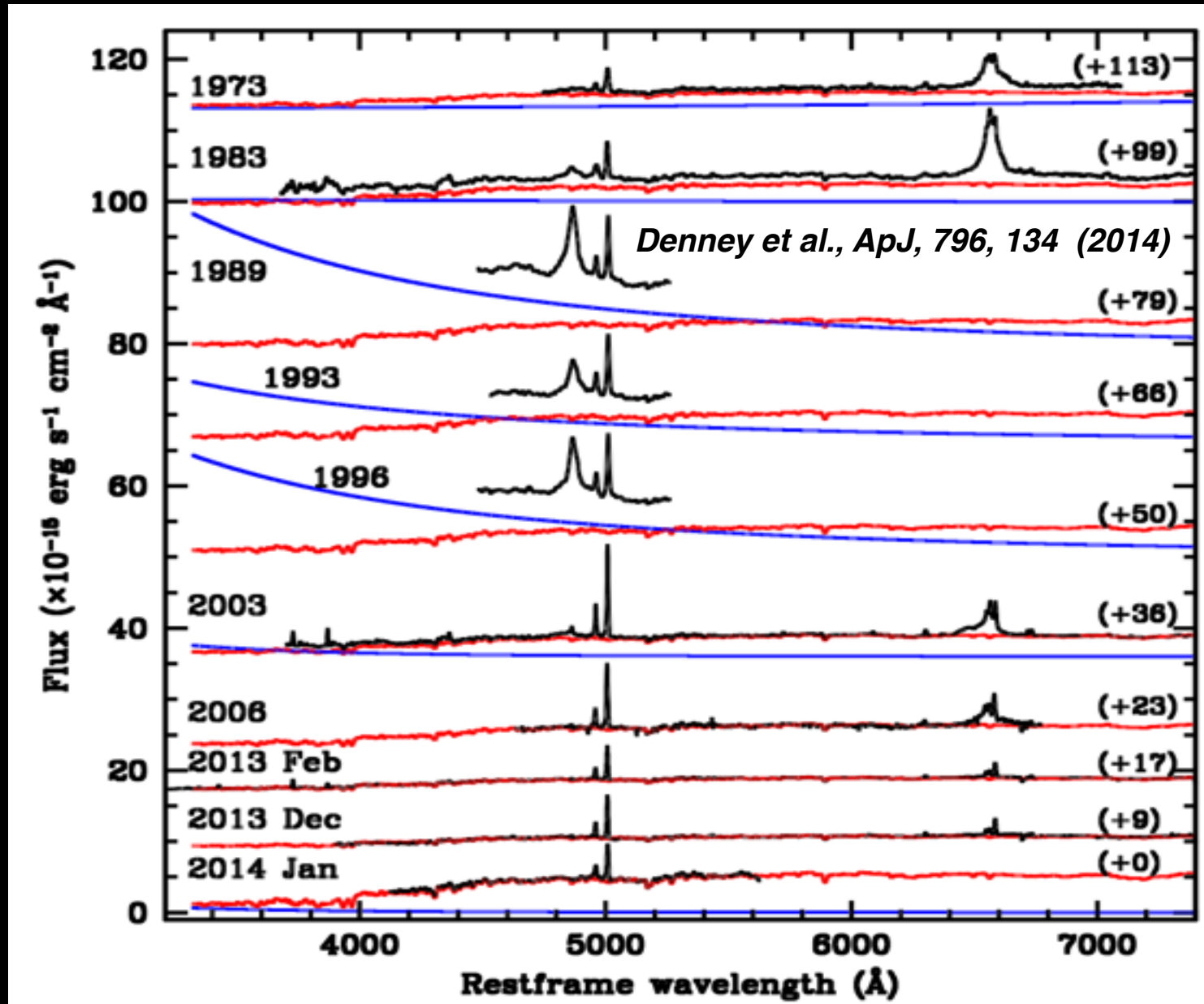
ACADEMIA SINICA  
Institute of Astronomy and Astrophysics

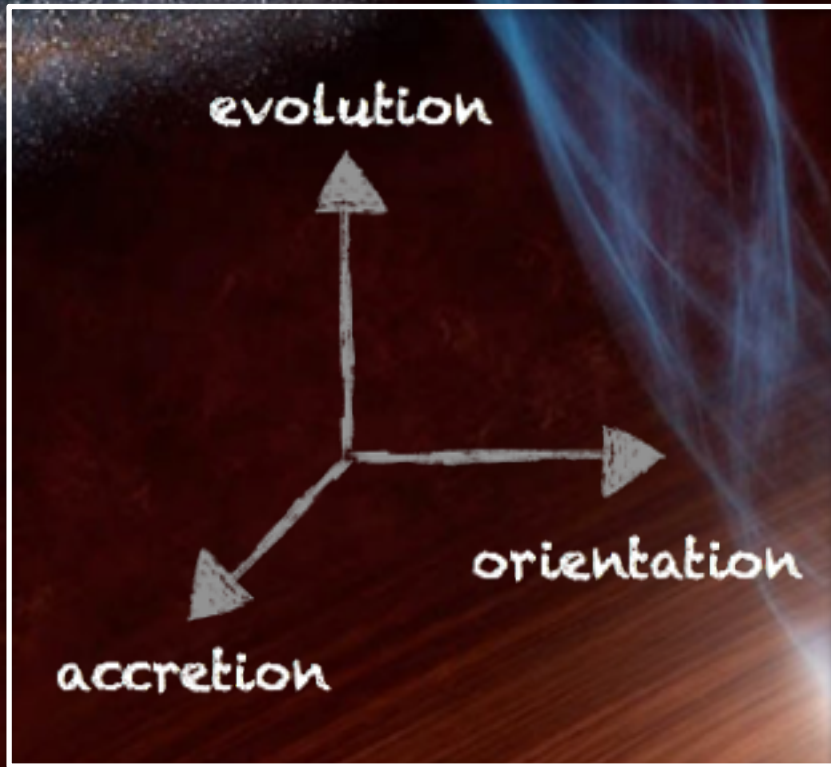
# Mrk 590: the Case of the Disappearing Broad Lines



(Image Credits: Bradley Peterson)

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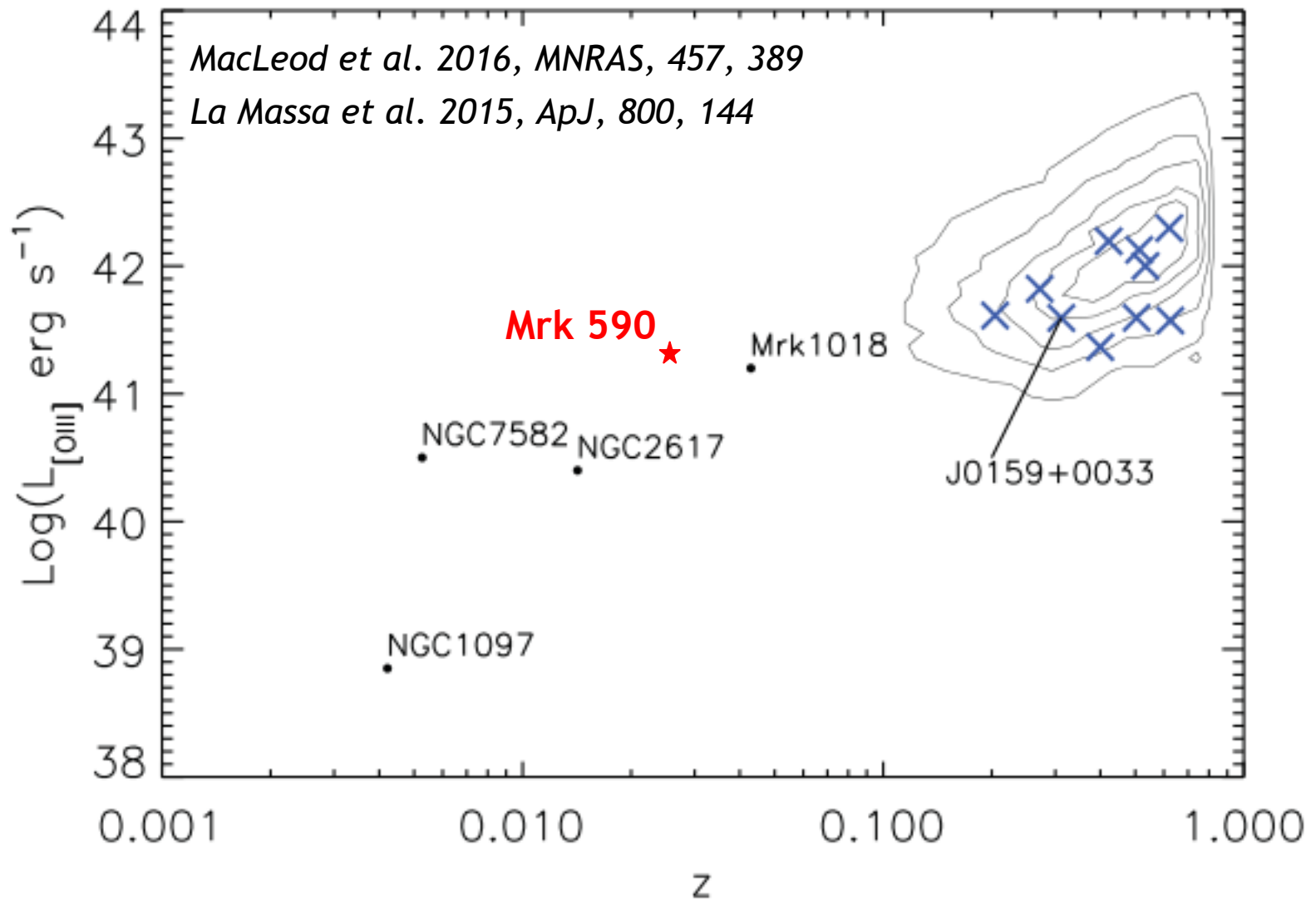




- Variable Accretion Rate?
- Changing Accretion Mode?
- Tidal Disruption Event?

- Variable Obscuration?

# Mrk 590: an excellent case study (1)





# Mrk 590: an excellent case study (2)

**Morphology:** SA(s)a [1]

**Redshift:** 0.0264 [1]

$V_{\text{sys}}$  (bary): 7910 km s<sup>-1</sup> [1]

$D_A$ : 109.5 Mpc (1'' = 531 pc)

**Inclination:** 25° [2]

**Black hole mass:**  
4.75 x 10<sup>7</sup> M<sub>⊙</sub> [3]

**AGN  $L_{\text{bol}}$  (1990s):**  
5.8 x 10<sup>44</sup> erg s<sup>-1</sup> [3]

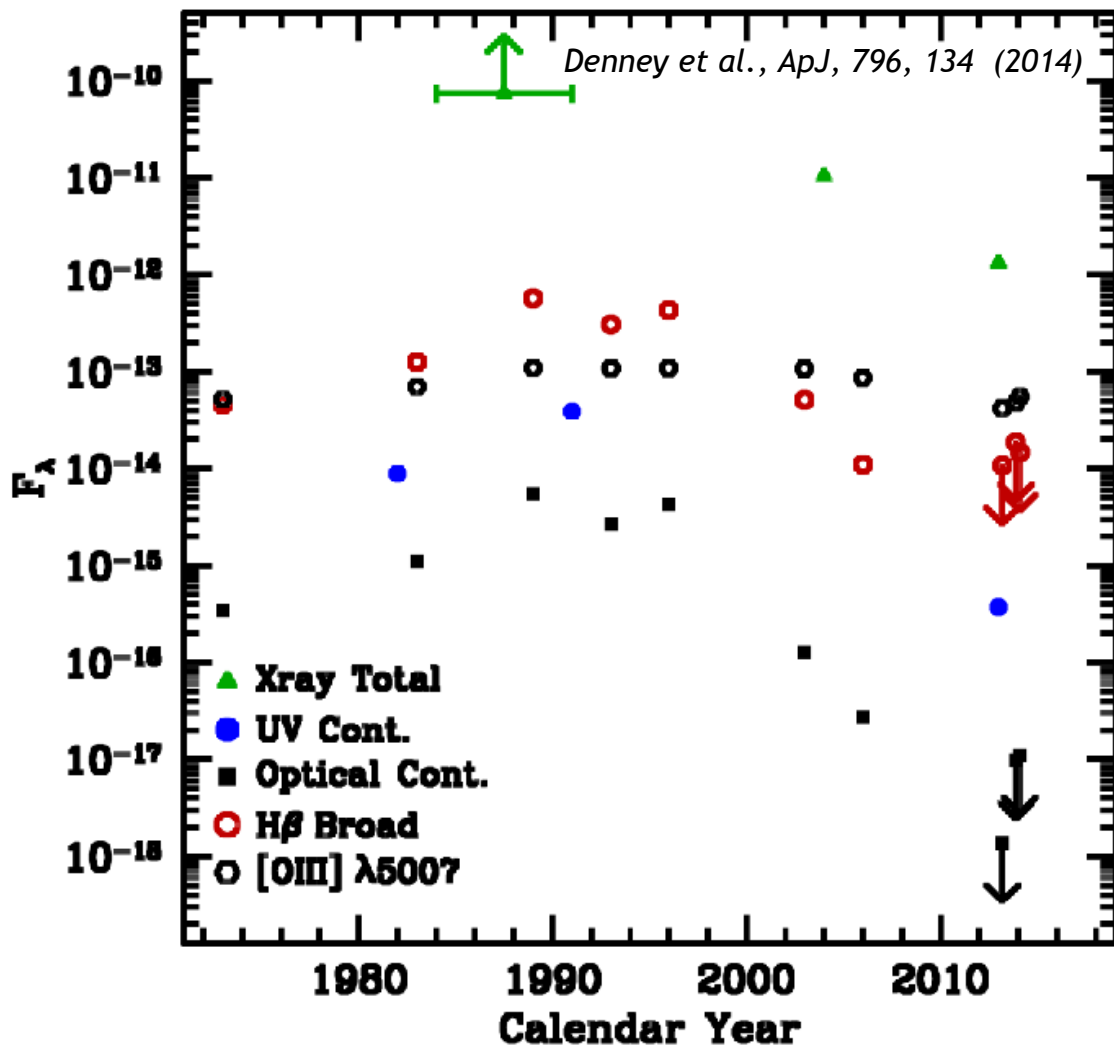
**AGN  $L_{\text{bol}}$  (2013):**  
3.4 x 10<sup>42</sup> erg s<sup>-1</sup> [4]

[1] NASA Extragalactic Database

[2] Whittle 1992, ApJS 79, 49

[3] Peterson+ 2004, ApJ, 613, 682

[4] Denney+ 2014, ApJ, 796, 134



# What we want to find out

- Is the radio emission variable? If so, why?
- What is its current mode of accretion - thin disk, hot accretion flow, combination of both?
- Is the central region running out of gas?

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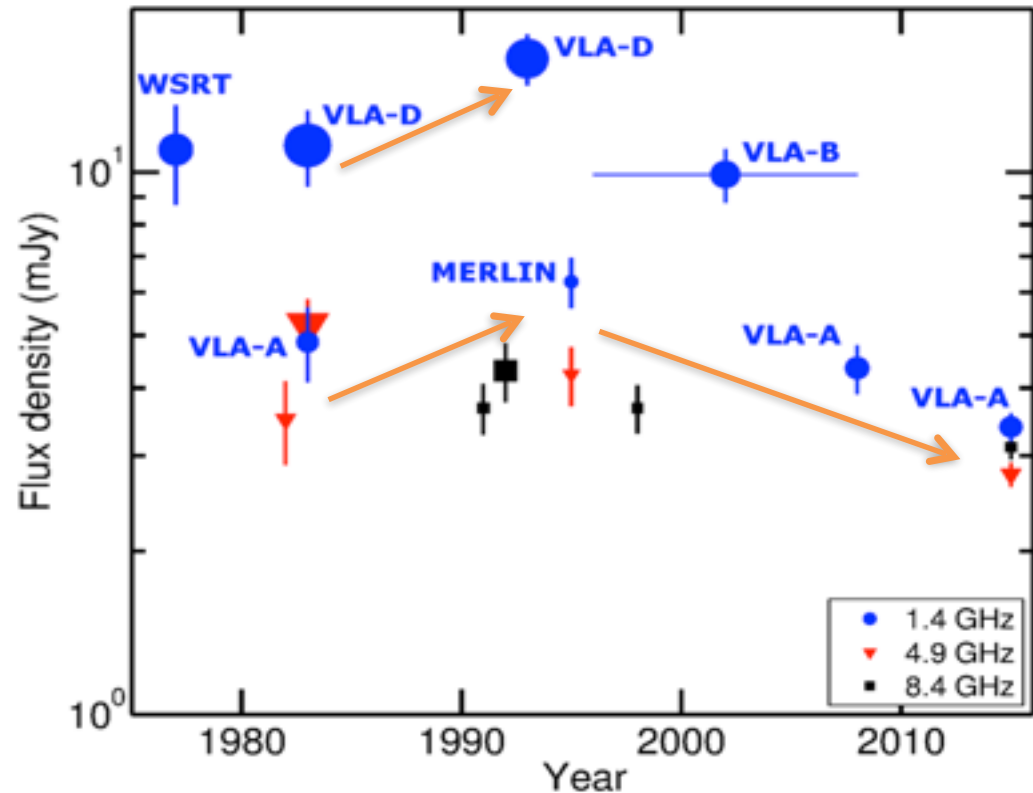
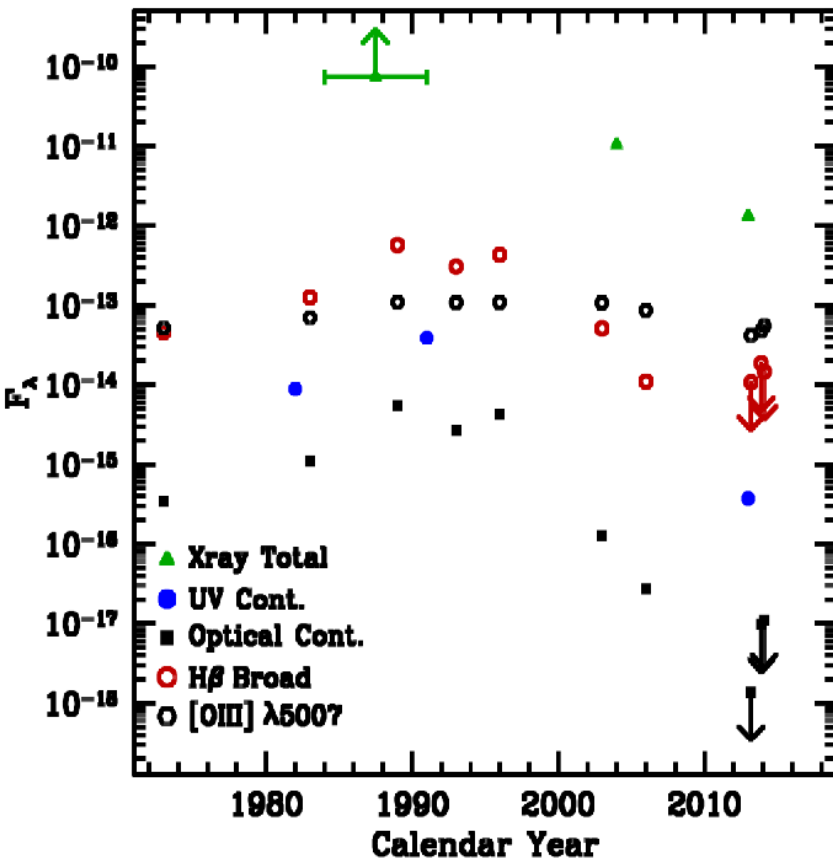


# Radio Variability

- 46%, 34%, and 13% flux density decreases between the 1990s and 2015 at 1.4 GHz, 5 GHz and 8.4 GHz respectively
- Instrumental effects ruled out, and interstellar scintillation unlikely
- Further evidence against obscuration

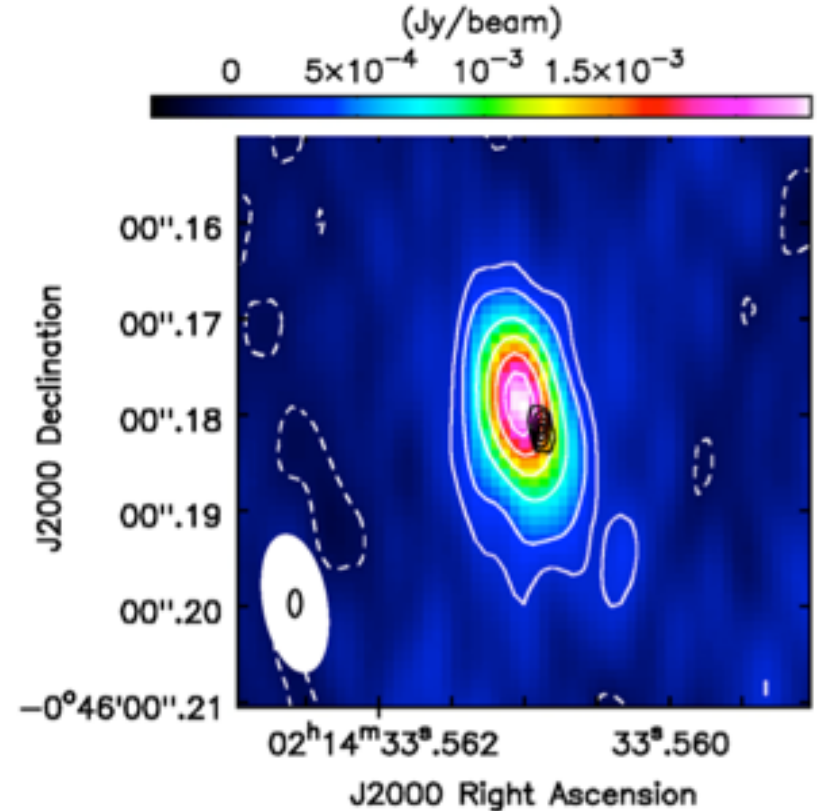
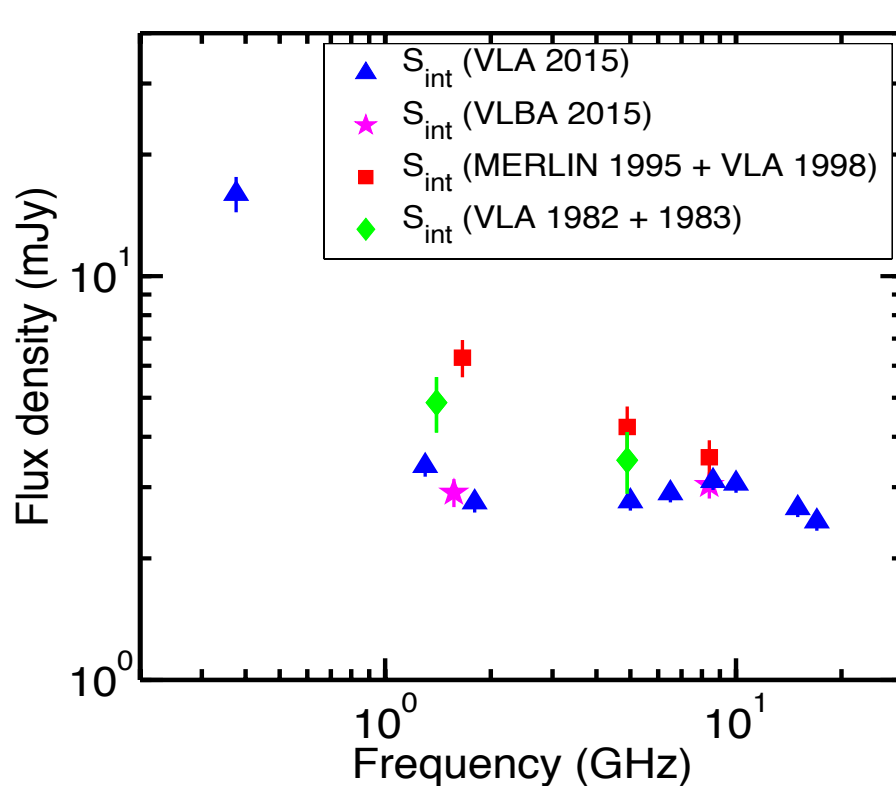
*Denney et al., ApJ, 796, 134 (2014)*

*Koay et al. 2016, MNRAS, 460, 304*



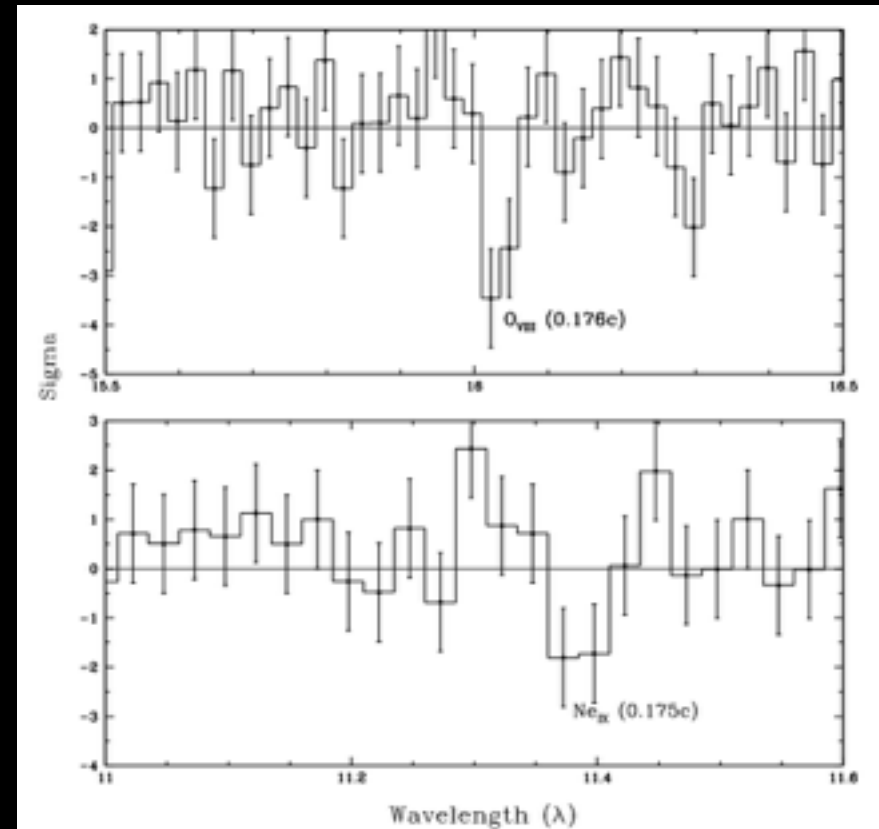
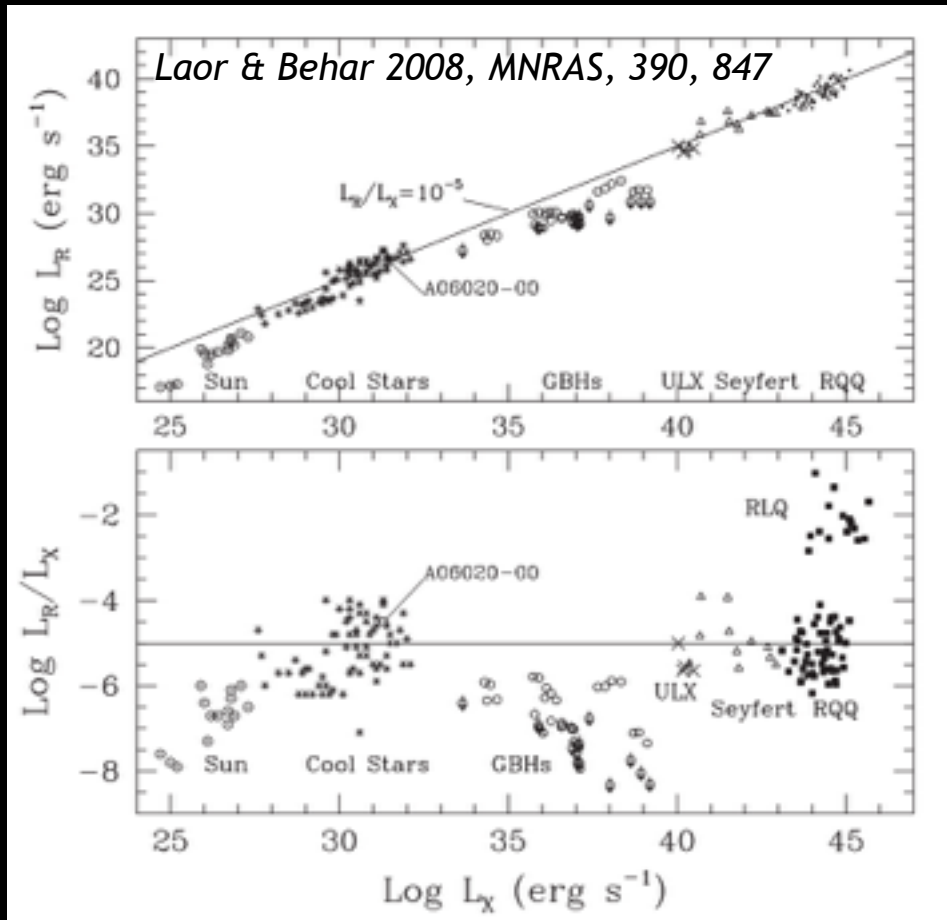
# Origin of Radio Emission

- Unresolved down to 1 pc scales
- Flat spectral index of 0.02 between 1.5 and 8 GHz
- Brightness temperature  $T_b \sim 10^8$  K
- Consistent with non-thermal, optically thick synchrotron emission



# Radio Coronal Winds?

- $\log(L_R/L_X) \sim -5$ , similar to coronally active stars, i.e., magnetized coronal winds
- Could also be an unresolved (failed?) jet, associated with the outflows detected in X-ray absorption ( $10^{-4}$  pc from black hole)?



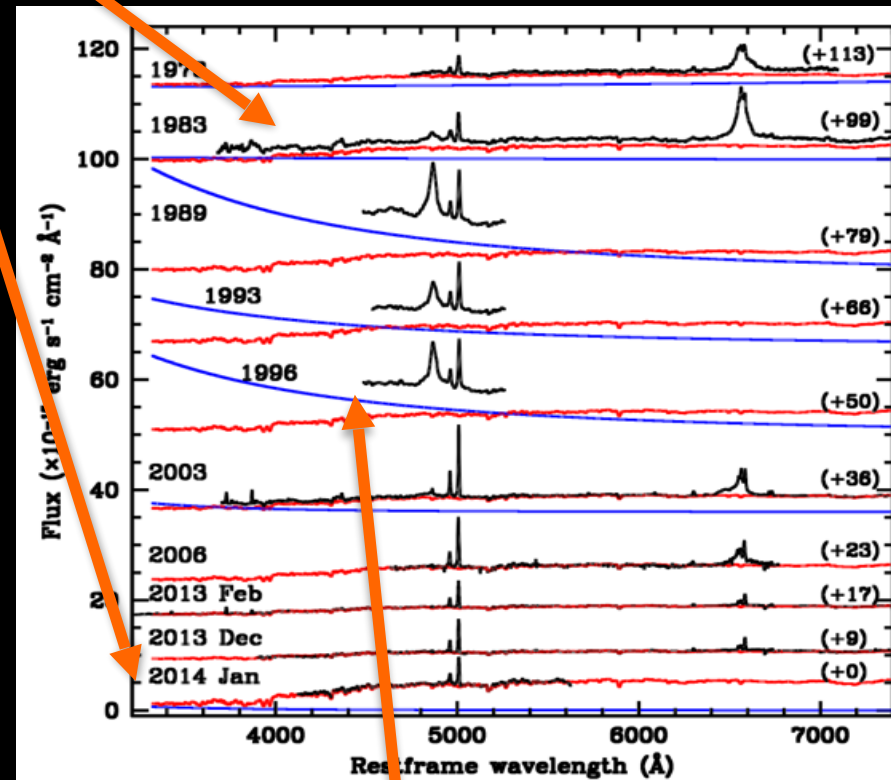
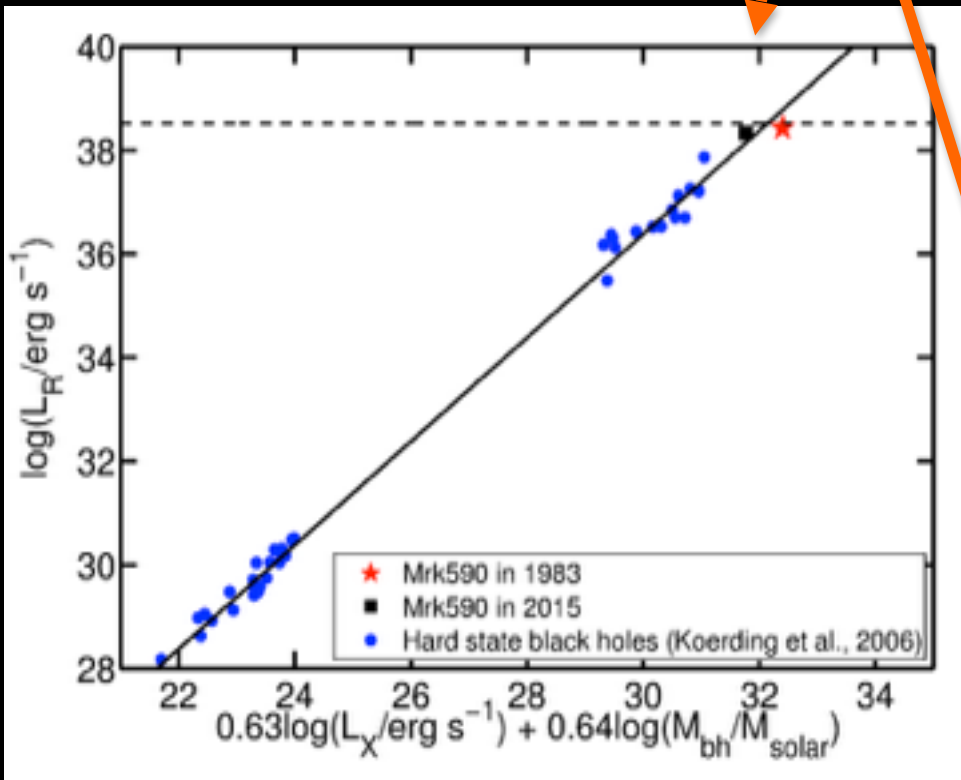
# Has Mrk 590 Changed Accretion Modes?

low/hard state in early 1980s and 2015?

$$L_{\text{bol}}/L_{\text{Edd}}(2015) \sim 0.006$$

Koay et al. 2016, MNRAS, 460, 304

Denney et al. (2014)



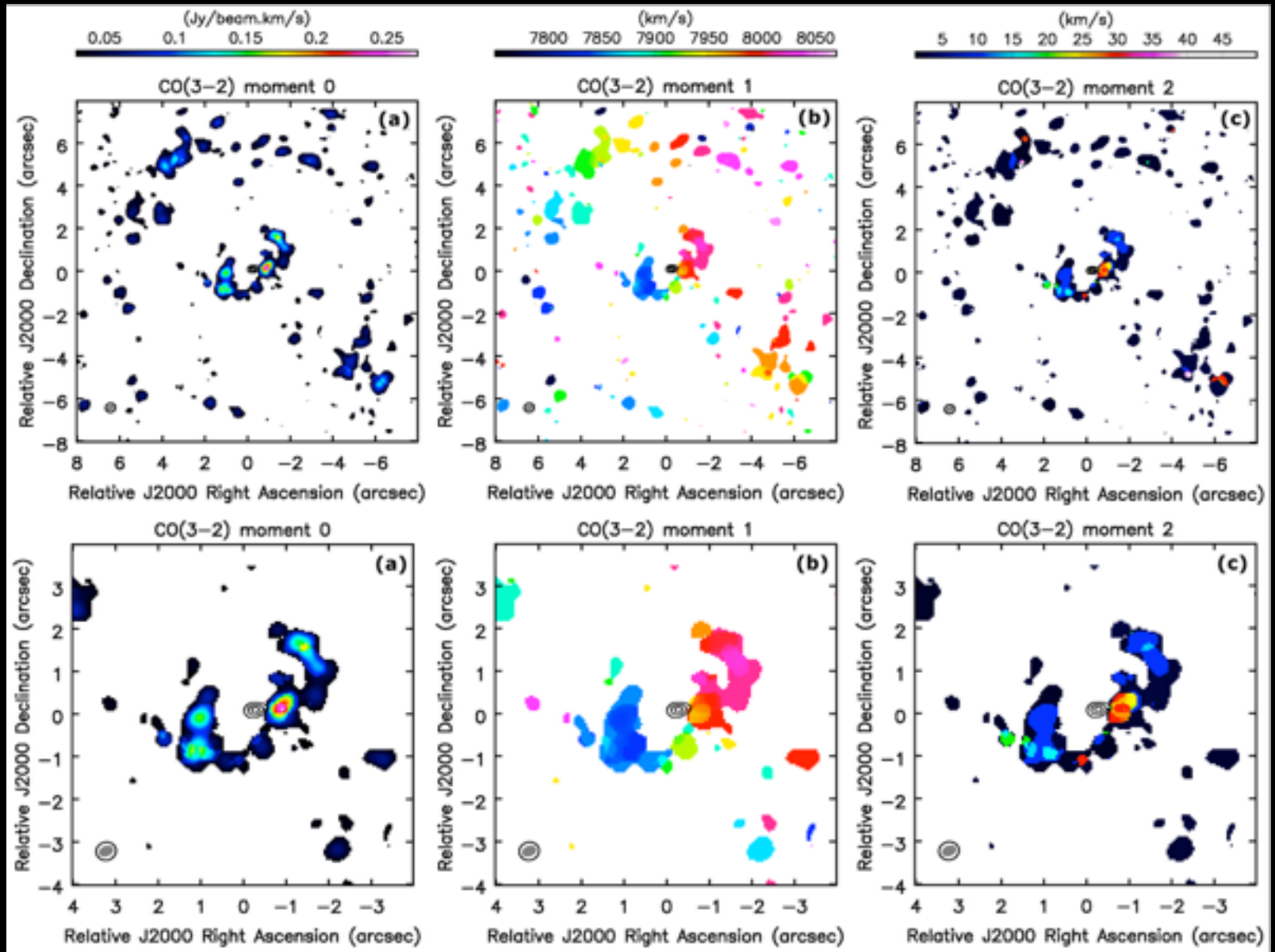
$$L_{\text{bol}}/L_{\text{Edd}}(1990\text{s}) \sim 0.08$$

High/soft state in the 1990s?

# What we want to find out

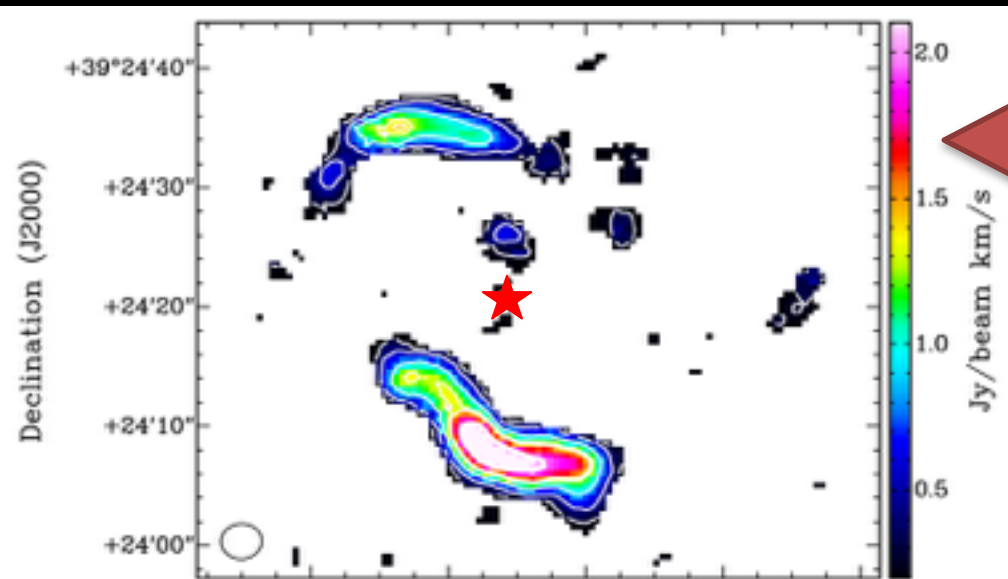
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# Is the central engine running out of gas?

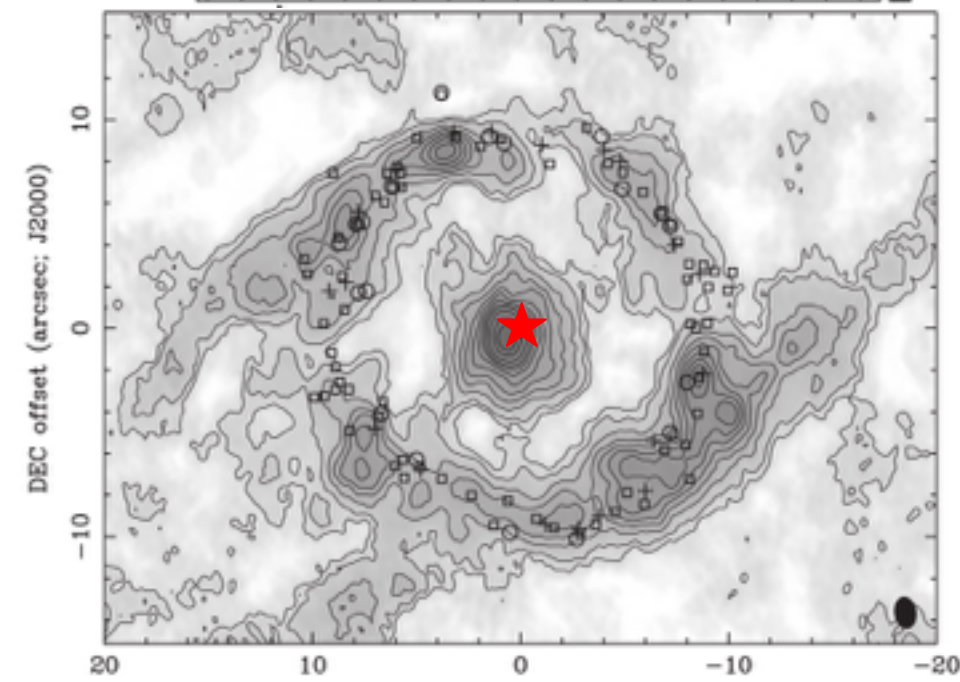




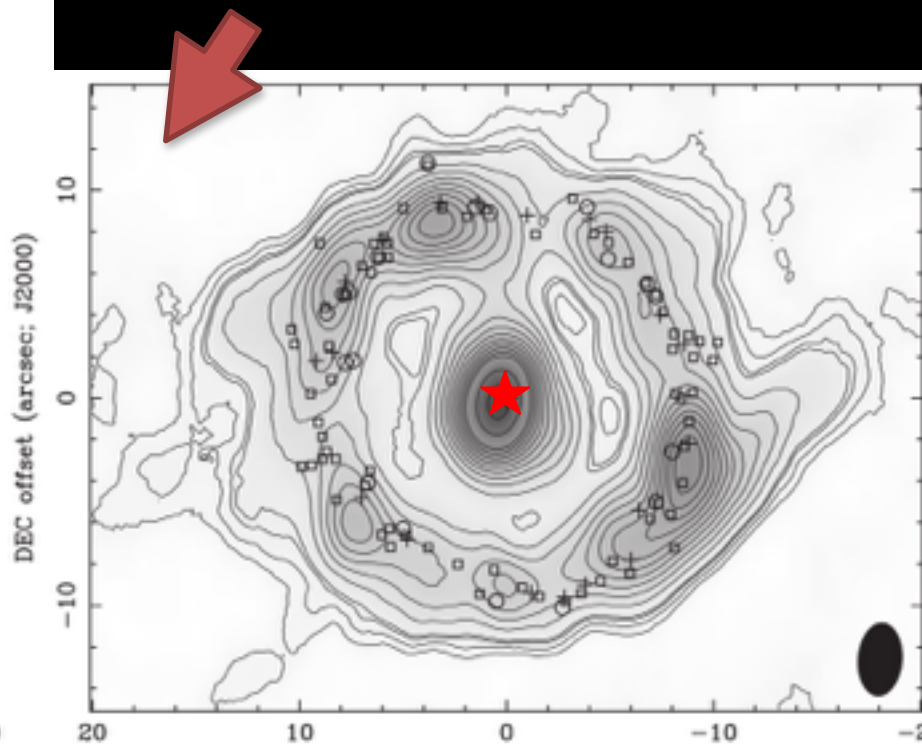
# What about other nearby changing-Look AGNs?



NGC 4151, CO(1-0), moment 0  
*Dumas et al. 2010, ApJ, 721, 911*



NGC 1097, CO(2-1) and CO(3-2), moment 0  
*Hsieh et al. 2011, ApJ, 736, 129*





# Summary: More questions than answers!

- Long-term radio variations consistent with that observed at optical-UV wavelengths provides further evidence against obscuration in Mrk 590
- Compact radio emission consistent with sub-pc scale jet or radio corona
- Current accretion state - inner ADAF with outer truncated disk?
- What about radio (and sub-mm) variability of other changing-look AGNs?
- no CO gas detected in central 150 pc of Mrk 590 - constraining the H<sub>2</sub> gas mass to  $< 10^5$  solar masses. Do other changing-look AGNs have similar morphologies?