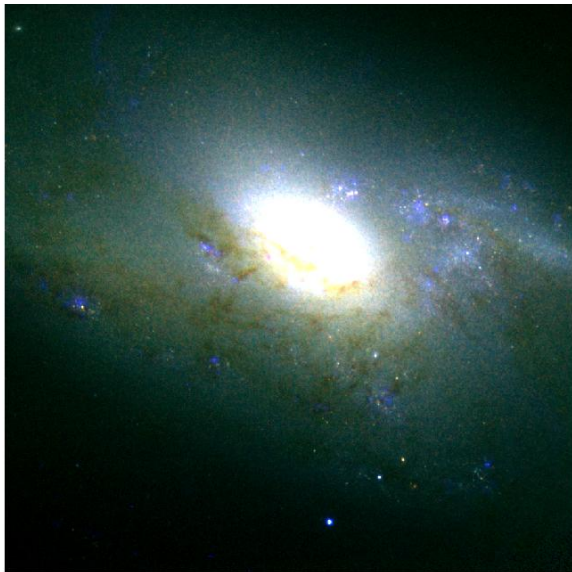


# The bulge of NGC4258

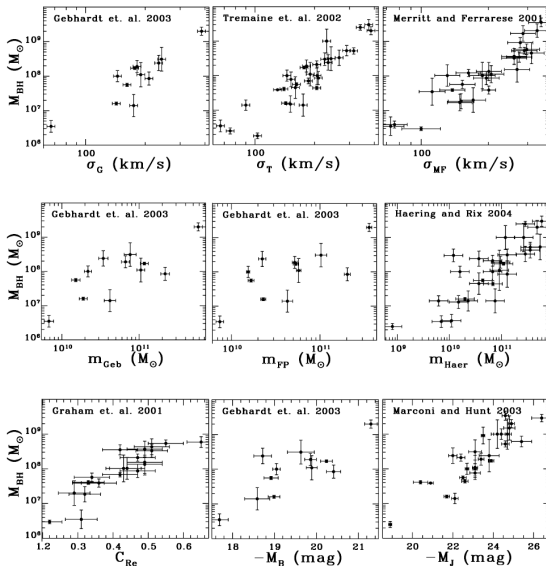
Francesco Costagliola  
Lauri Juhan Liivamägi  
Núria Piñol-Ferrer  
Steve Schulze  
Carolyn Villforth  
John Conway

Tuorla 2009



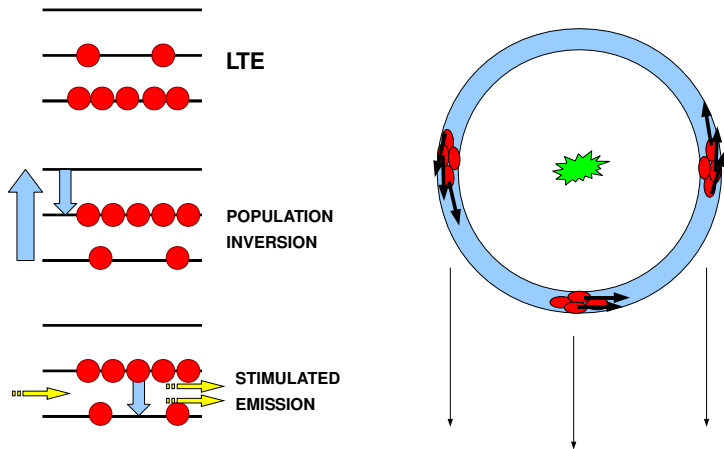
NGC4258 ( $J$ ,  $K_s$ ,  $H_\alpha$ )

# Introduction



Black Mass plotted against different predictor variables

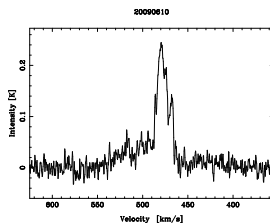
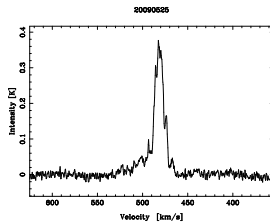
# Water maser



Maser mechanism

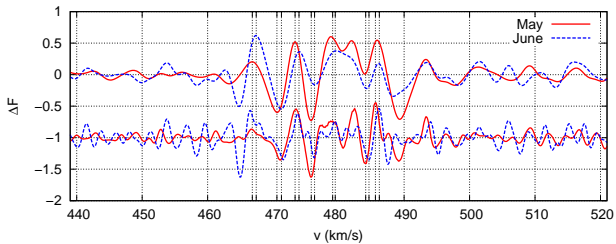
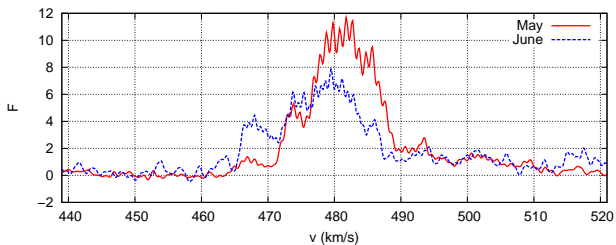
# Observations at OSO 20m

- Spectra of H<sub>2</sub>O maser at 22 GHz at two different epochs: May-June 2009
- May: 8 hours on source  
beam switching mode  
single polarization  
(resolution 0.16 Km/s); snr 43
- June: 4 hours on source  
beam switching mode  
dual polarization  
(resolution 0.33 Km/s); snr 20



Raw spectra

# 20m radio data



Wavelet decomposition of the central maser spectrum

- Velocity shift of features

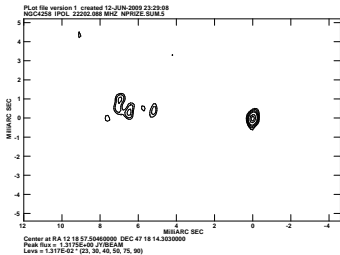
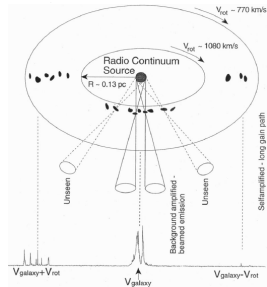
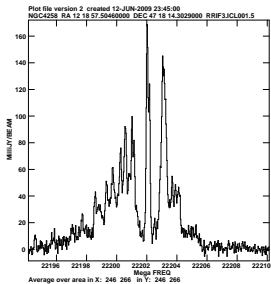
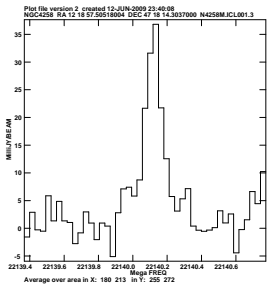
$$\Delta V = 0.5 \text{ km/s.}$$

- Centripetal acceleration

$$a = \frac{\Delta v}{\Delta t}$$

- $a = 12 \text{ km/s yr}^{-1} = 4 \times 10^{-4} \text{ m/s.}$

# VLBA data





# Derivation of BH mass and galaxy distance

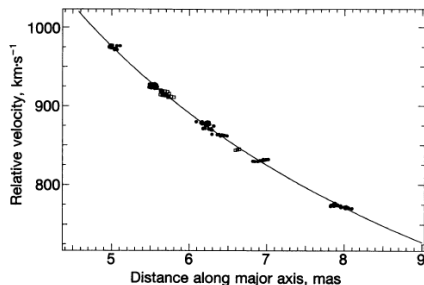
- Assuming Keplerian rotation

$$v_z - v_0 = \sqrt{\frac{GM}{R}}$$

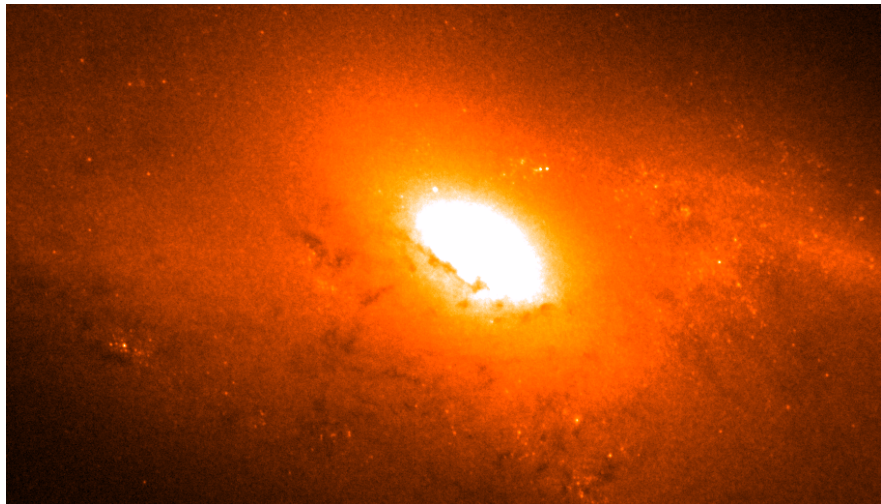
- Centripetal acceleration

$$a = \frac{GM}{R^2}$$

- $D = 1.7 Mpc$        $M_{BH} = 6.5 \times 10^6 M_{\odot}$

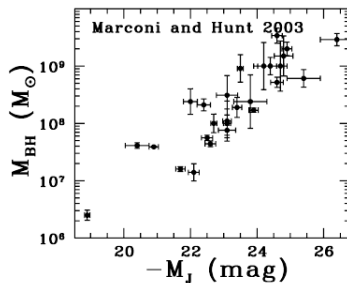


# Bulge of NGC4258



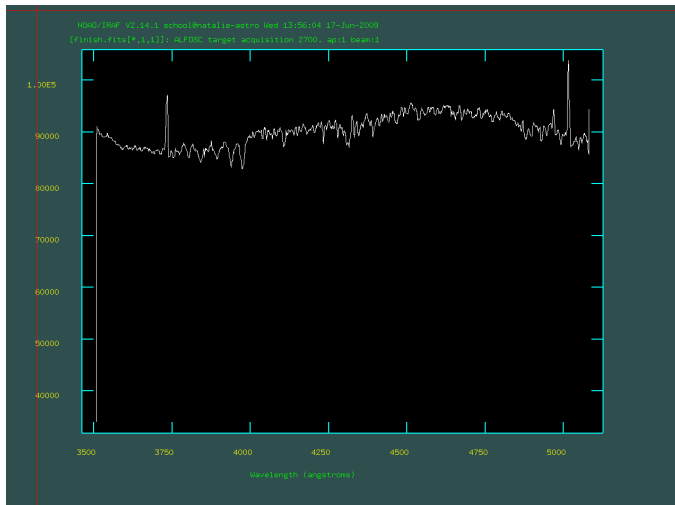
NGC4258 *J*

# Correlations between bulge luminosity and black hole mass

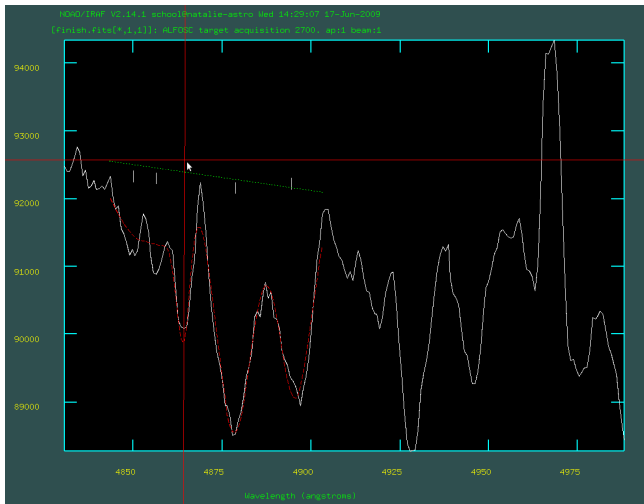


- $M_J = -19.84 \rightarrow M_{BH} = 5.1 \times 10^6 M_{\odot}$
- $M_{K_s} = -21.24 \rightarrow M_{BH} = 9.3 \times 10^6 M_{\odot}$

# Spectrum of NGC4258

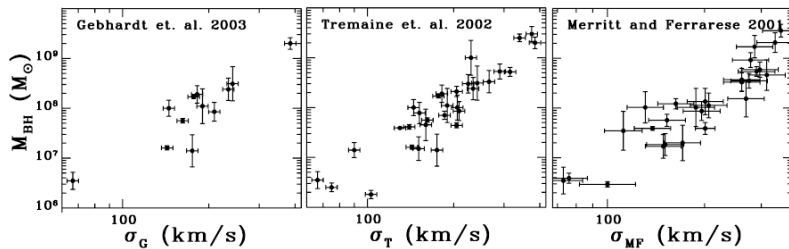


# Velocity dispersion of the bulge



$H_{\beta}$  line

# Black hole mass - velocity dispersion



- $\sigma \sim 315 \text{ km/h} \rightarrow M_{BH} < 10^{8\dots9} M_{\odot}$

# Summary

- Centripetal acceleration of the disk:  $\sim 12 \text{ km/h yr}^{-1}$
- Size of the disk: 0.05 pc
- Distance of the Galaxy 2 Mpc
- Radio and NIR observations give a black hole mass of about  $10^7 M_{\odot}$

# References

Moran, J.; Greenhill, L.; Herrnstein, J.; Diamond, P.; Miyoshi, M.; Nakai, N.; Inque, M., Probing Active Galactic Nuclei with H<sub>2</sub>O Megamasers, 1995, Proc. Nat. Acad. Sci. USA, 92, 25, 11427-11433

Marconi, A.; Hunt, L.K., The Relation between Black Hole Mass, Bulge Mass, and Near-Infrared Luminosity, 2003, ApJ, 589, 1, L21-L24

Novak, G.S.; Faber, S. M.; Dekel, A., On the Correlations of Massive Black Holes with Their Host Galaxies, 2006, ApJ, 637, 1, 96-103