

#### AGN spectral lines & SMBH

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# QSOs (AGN) emit radiation at a range of wavelengths from the radio to the X-ray ( $\gamma$ -ray)



#### Spectra of extragalactic objects



#### Model (Jovanovic & Popovic, in book Black Holes: Properties, Formation and Features, 2009)



What can we learn from spectral lines about SMBH?

 Accretion disk (AD) => characteristics of SMBH (rotating or not), Fe K alpha (6.4 KeV)

AGN, mass of black holes, accretion rates
 =>broad optical lines









The X-ray accretion disk – Popović et al. 2003, A&A, 398, 975; Popović et al 2006, ApJ, 637, 620



#### Perturbation in AD (Jovanovic, Popovic, Stalevski 2010, ApJ, accepted)



Model vs. observations: 3C390.3 (Shapovalova, Popovic, et al. 2010, A&A, accepted, Jovanovic, Popovic, Stalevski 2010, ApJ)



#### Mass of SMBH

- $MBH = f * r_{BLR}FWHM^2/G$
- $r_{BLR} = a * (L5100)^{\gamma} pc$
- where L5100 is the continuum luminosity  $(\lambda L \lambda)$  at 5100 A in 10<sup>46</sup> erg s<sup>-1</sup>
- and  $\gamma = 0.6 \pm 0.1$ , constant *a* depends on the line in question. For H $\beta$ , *a*  $\simeq 0.4$  pc (e,g, Bentz et al. 2009)

## **PROBLEMS** - geometry



# PROBLEMS

- Monitoring program
  Popovic et al. 2008
  reverberation mapp
- Different sizes of II line emission reg Popovic, Dimitrije



#### **PROBLEMS** – kinematics



# Different spectral range and different regions (e.g. jets)





## Some proposals for collaboration

- Connection between the BLR (geometry physics, etc.) and radio, gamma, x-ray properties
- Different spectral characteristics for broad line AGNs with FWHM<3000 km/s (>3000 km/s), what is with as e.g. X-ray emission? Etc.

Thank you for your attention

# 8<sup>th</sup> SCSLSA, Serbia, 6-10 June 2011

- 8<sup>th</sup> Serbian Conference on Spectral Line Shapes (SCSLSA)
- www.scslsa.matf.bg.ac.rs

spectral lines and black holes?

