Connection between the X-ray, UV and optical emission line regions of AGNs

L. Č. Popović

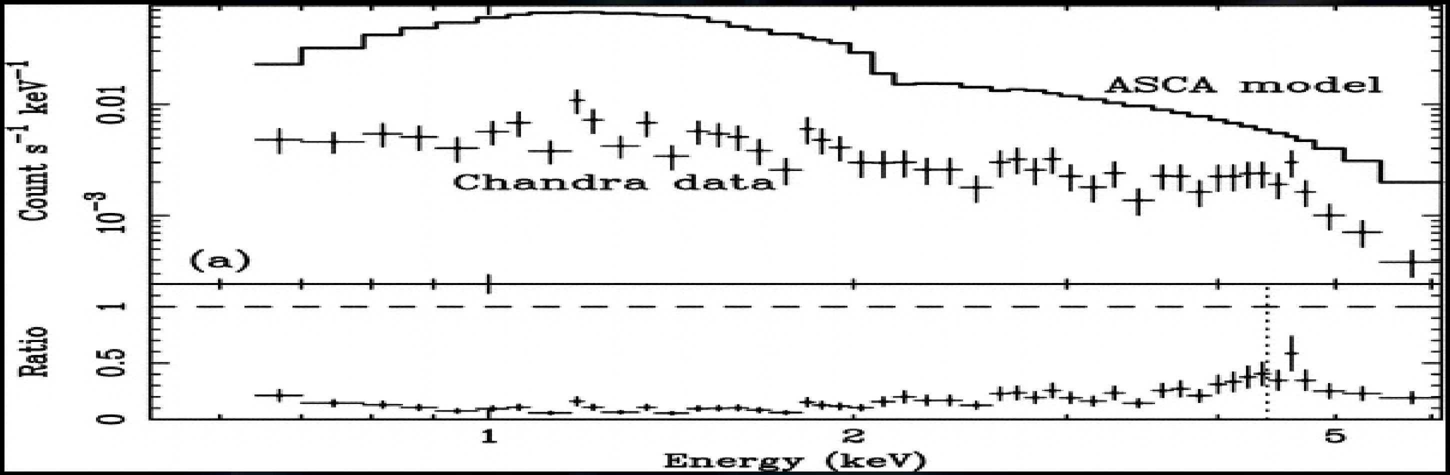
Astronomical Observatory, Belgrade, Serbia

Astrophysicalisches Institut Potsdam, Potsdam, Germany

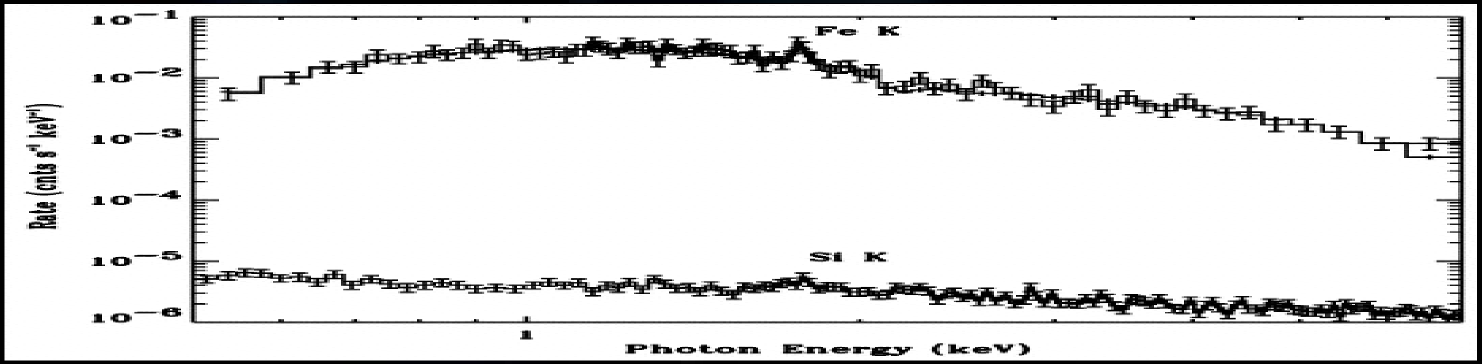
Spectral lines

- X-ray - Fe K-alpha line
- Broad UV lines - Ly-alpha, C IV, CIII], Mg II
- Broad optical lines - Balmer lines

X-ray

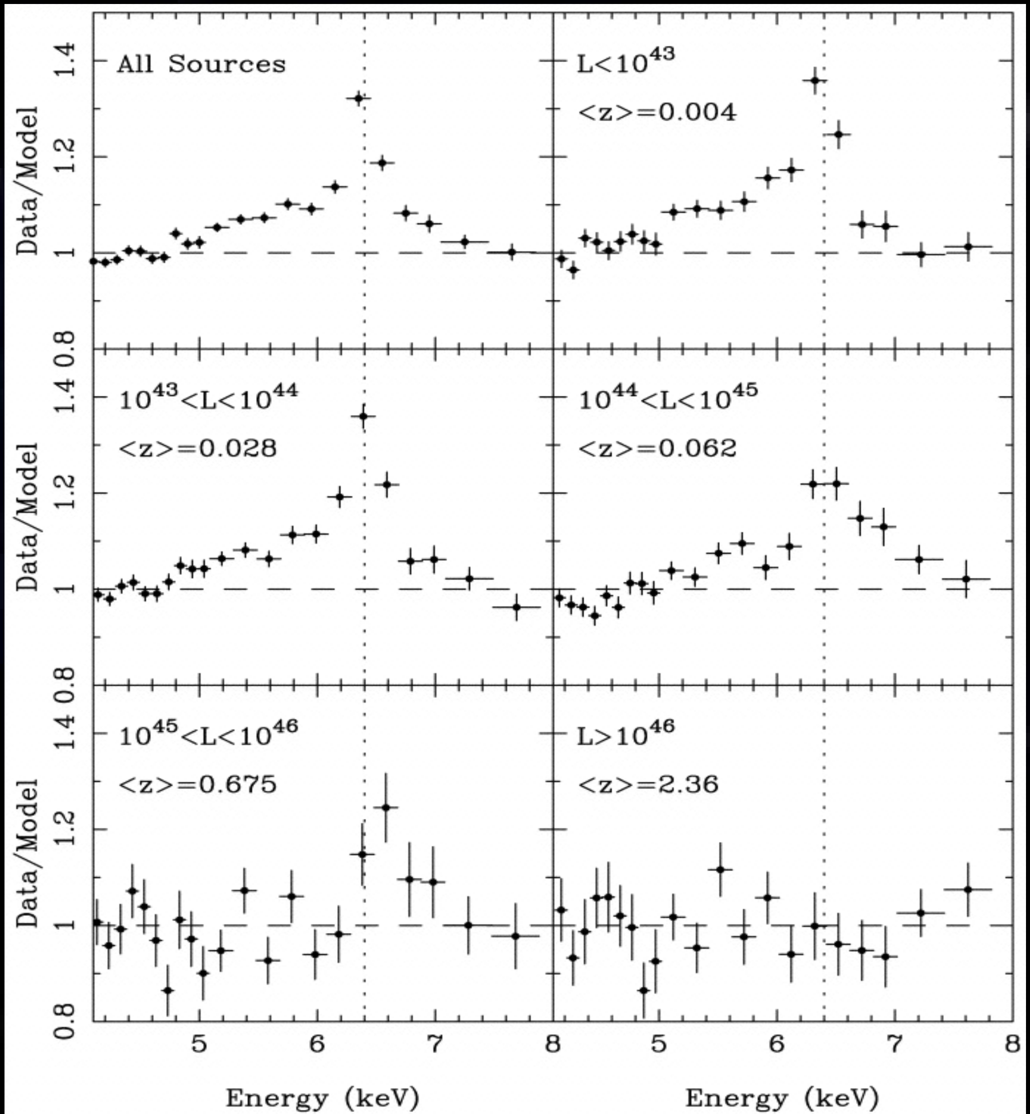


ASCA model
Chandra data
(a)
Count s^{-1} keV^{-1}
0.01
10^{-3}
Ratio
1
0.5
0
1
2
5
Energy (keV)

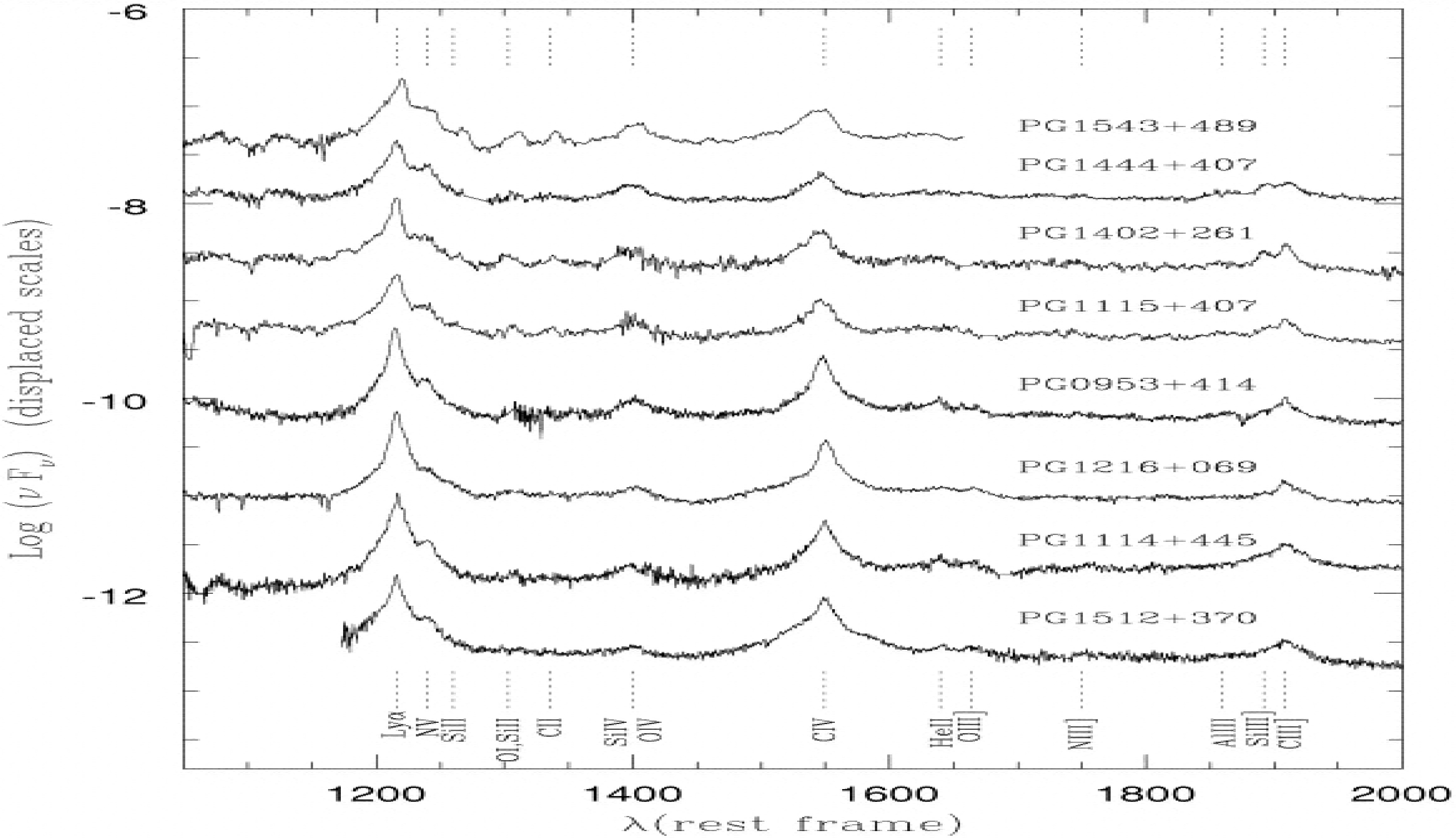


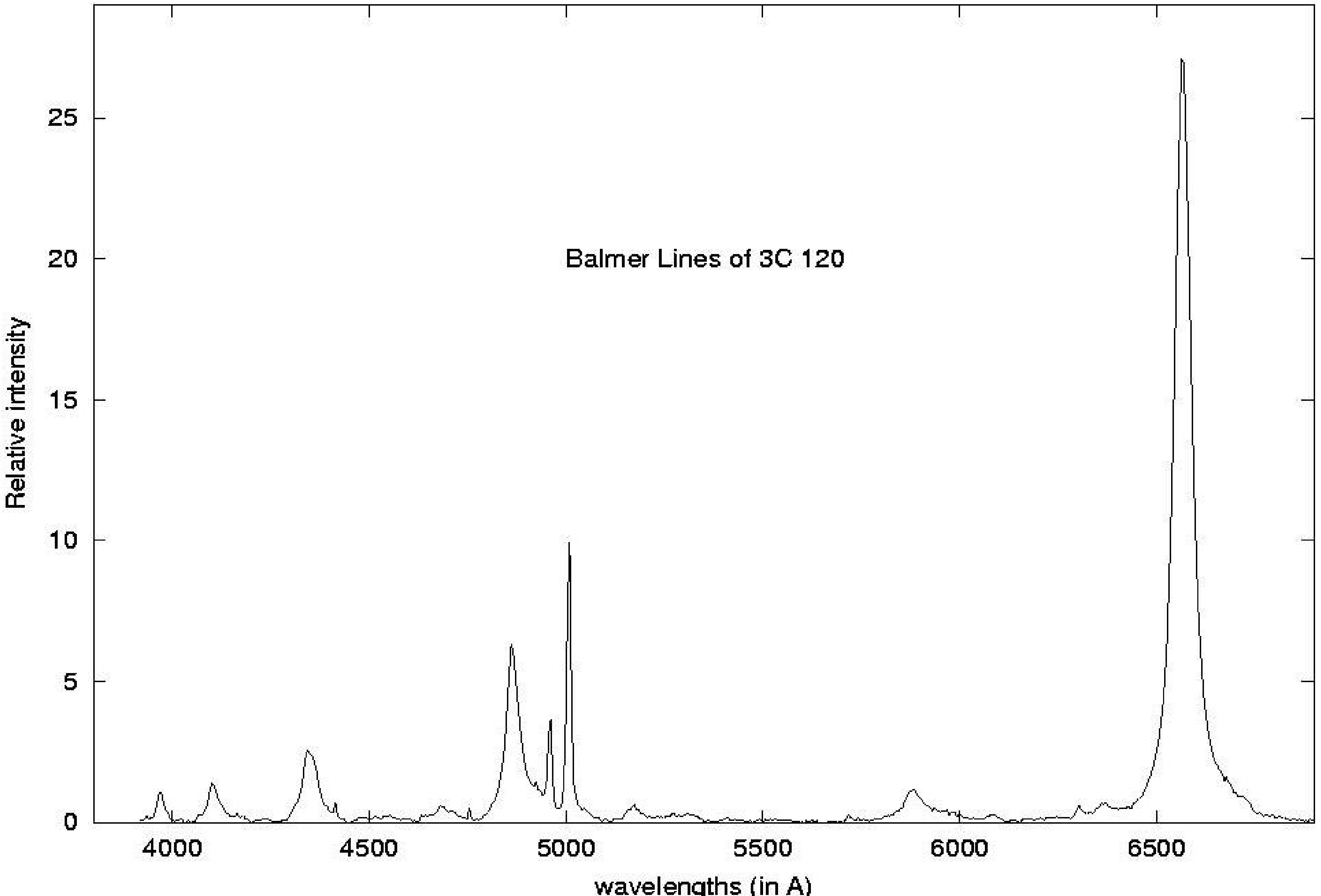
Fe K
Si K
10^{-1}
10^{-2}
10^{-3}
10^{-4}
10^{-5}
10^{-6}
Rate (cnts s^{-1} keV^{-1})
1
Photon Energy (keV)

Nandra et al. 1997, ApJ, 447,602; 488,L91



UV-lines (Wills et al. 1999, ApJ, 515, L53)




Balmer Lines of 3C 120
Relative intensity
wavelengths (in A)
0
5
10
15
20
25
4000
4500
5000
5500
6000
6500

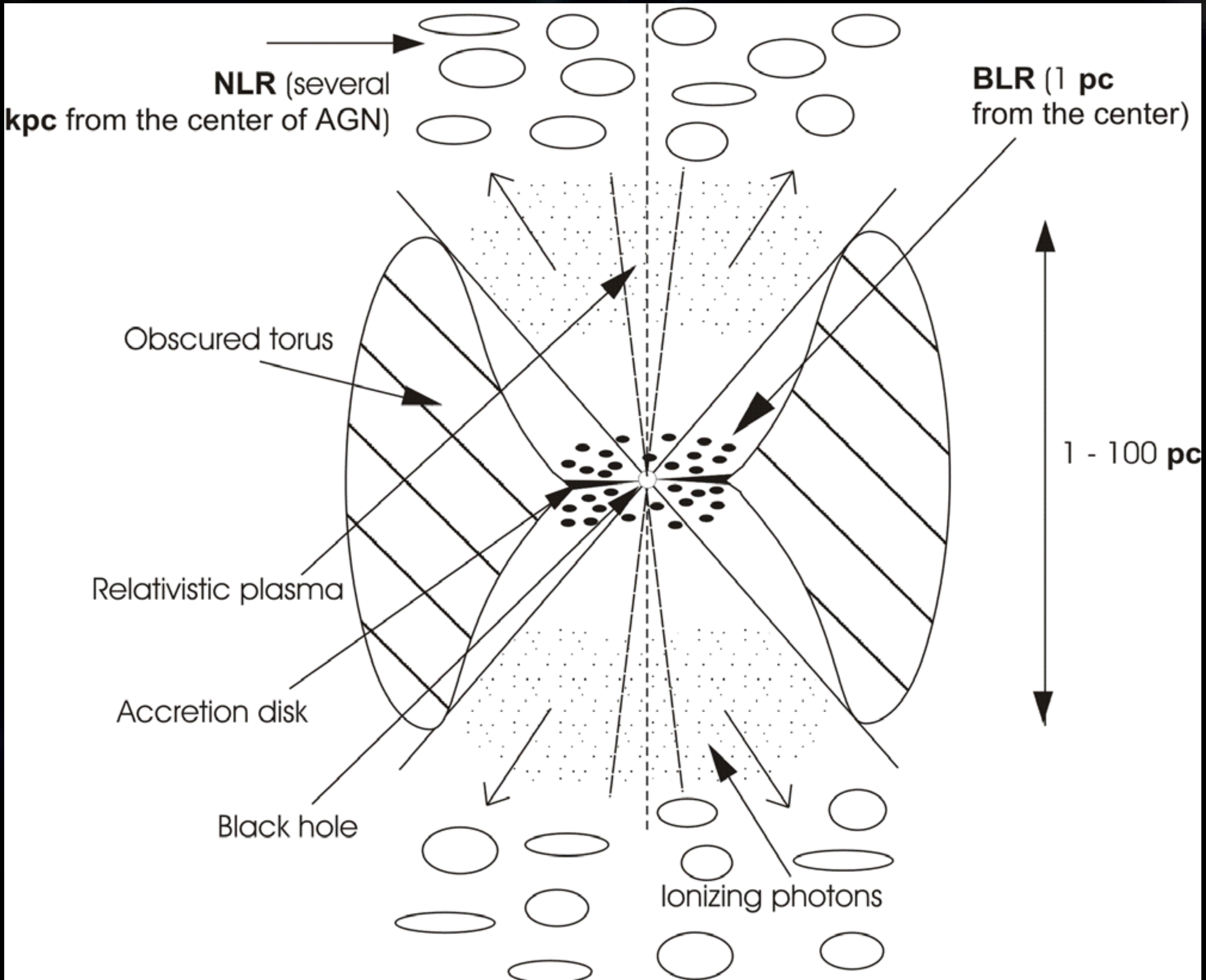
Some correlations

- Narrower optical lines (H-beta) => steeper slopes of X-ray continua (Boller et al. 1996, A&A, 305, 53)
- H-beta narrower =>[OIII] emission decreases => higher NV/CIV (Wills et al. 1999, ApJ, 515, L53)
- Higher L(2-10 keV) => higher L[OIII] (Kramer et al. 2004, ApJ, 607, 794)

The questions

- Is there any similarity between line shapes (Fe K, UV and Balmer lines)?
- =>
- Different physics and kinematics of line emitting regions?
- Stratification of an emitting region?

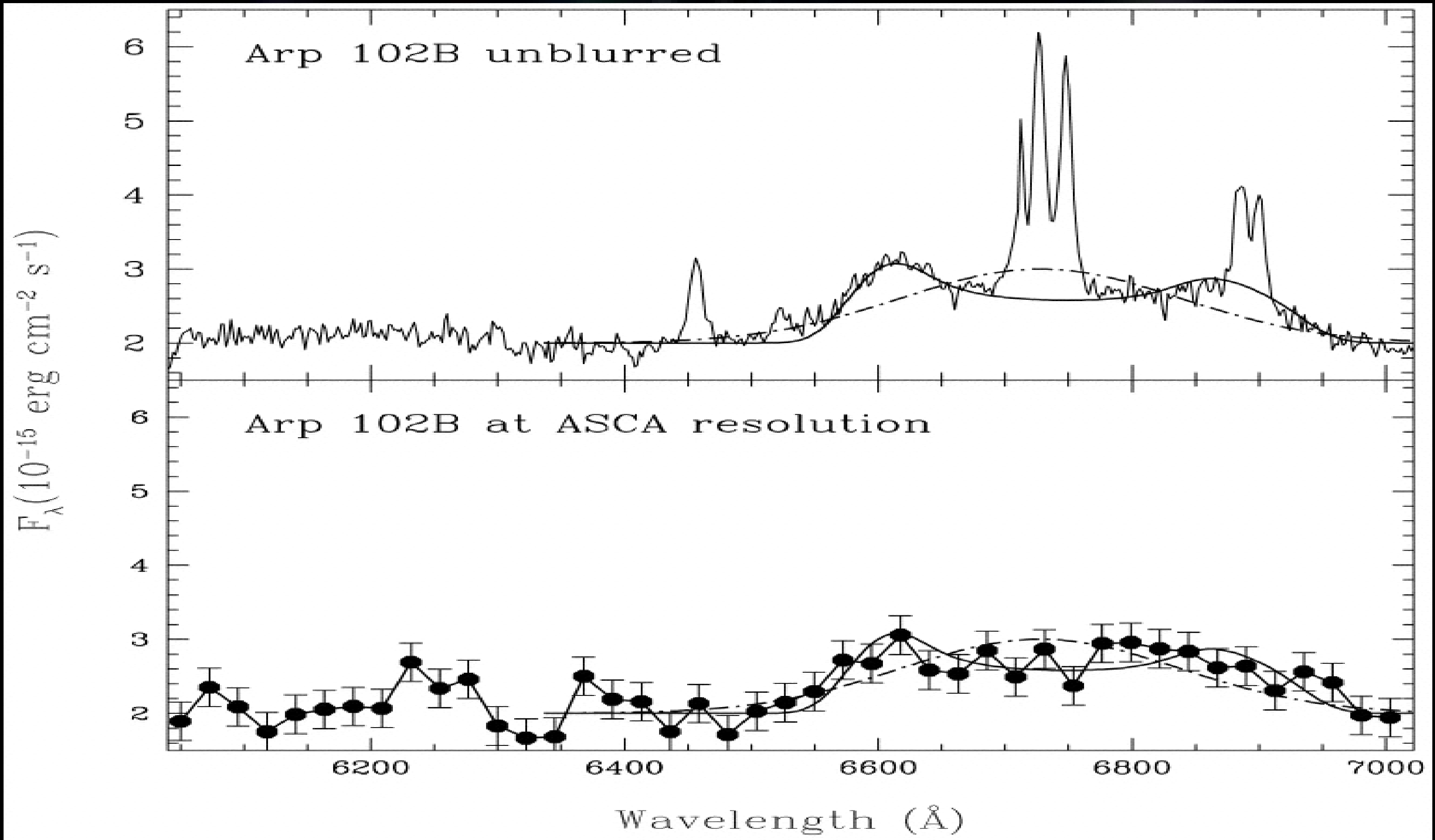
THE MODEL


NLR (several
kpc from the center of AGN)
BLR (1 **pc**
from the center)
Obscured torus
1 - 100 **pc**
Relativistic plasma
Accretion disk
Black hole
Ionizing photons

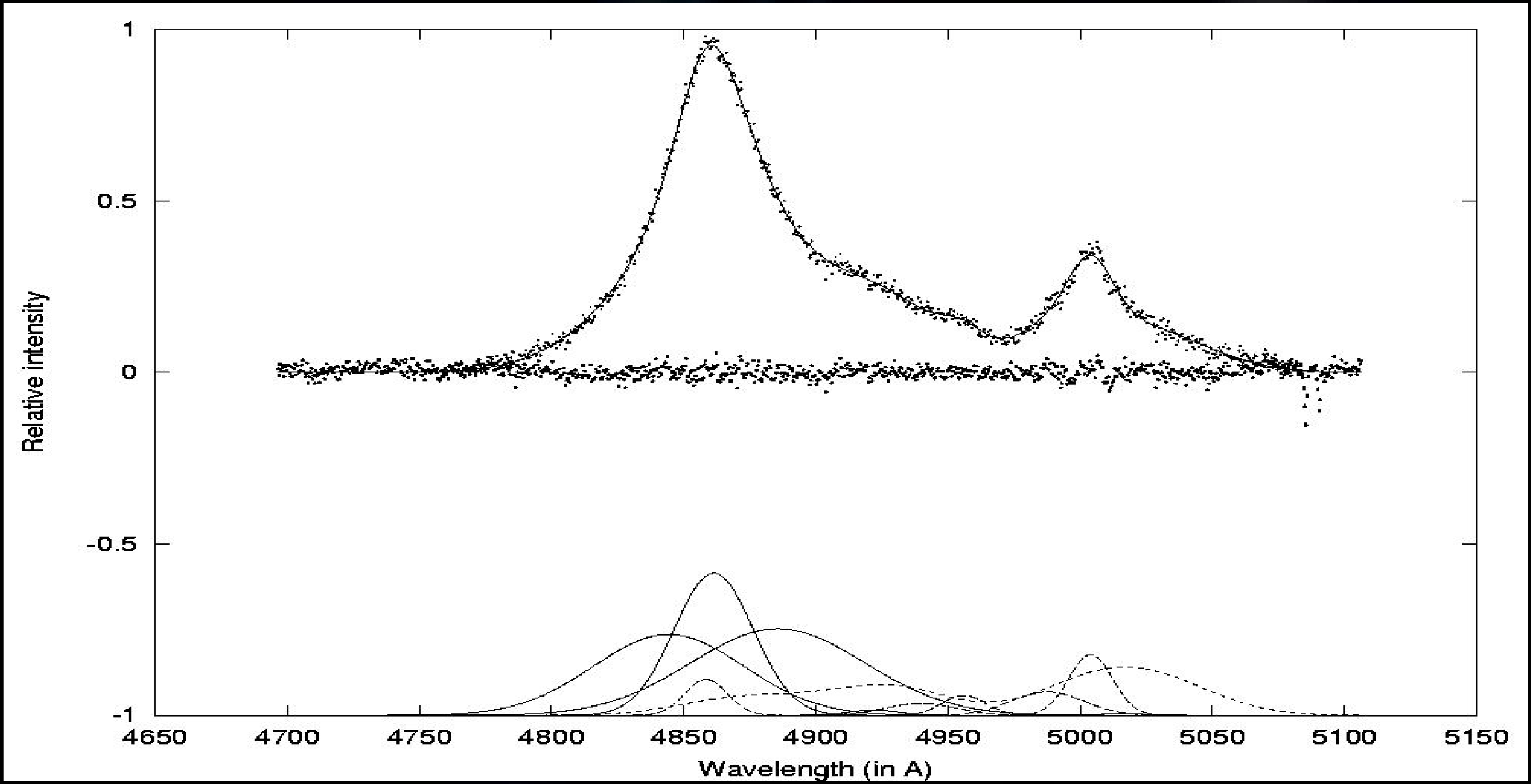
Some problems:

- Low resolution in the X-ray
- Satellite lines in the UV and Optical
- Different optical depth of UV and optical lines

Low resolution in the X-ray (Sulentic et al. 1998, ApJ, 501, 54)



Satellite lines (3C 273)



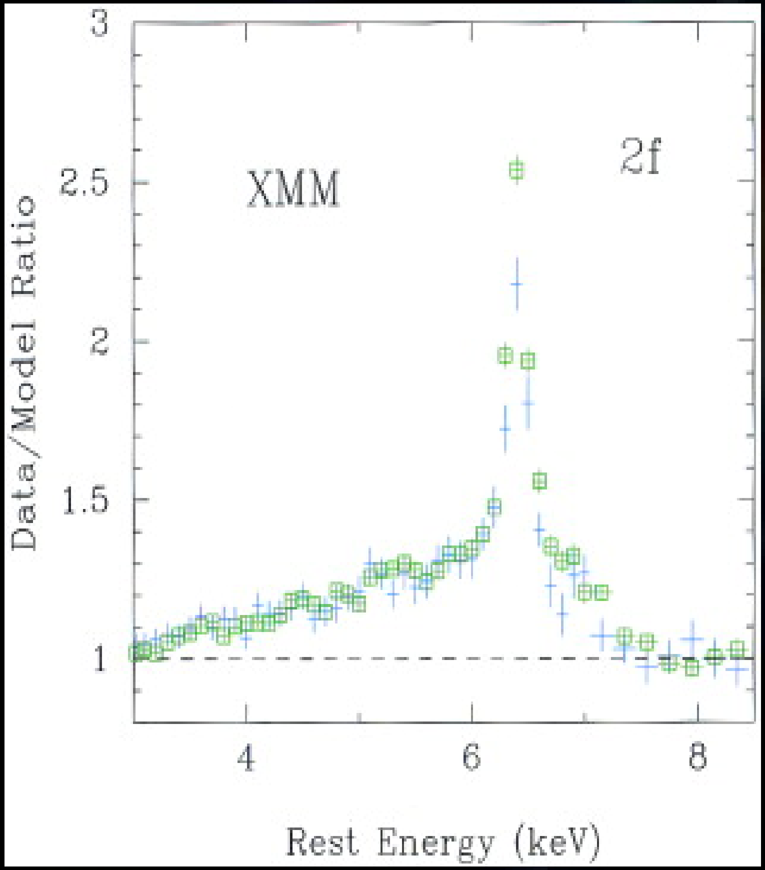
The aims

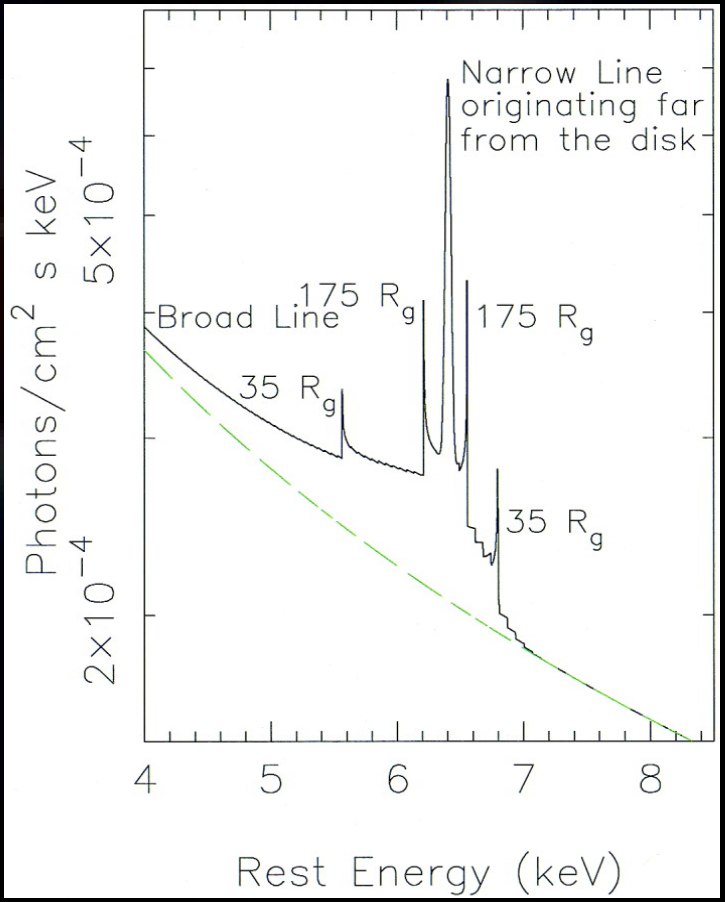
1) For a sample of AGNs which Balmer lines can be modeled by the two-component model (accretion disk + spherical emitting region; Popovic et al. 2002, A&A, 390, 473; Popovic et al. 2003, ApJ, 599, 185; Popovic et al. 2004, A&A, 423, 909) find the kinematics of UV and Fe K line regions (comparison of geometries)
2) Physical properties of optical BLR (Popovic 2003, ApJ, 599, 140) connect with Fe K and UV emitting region

NGC 3516 – an example

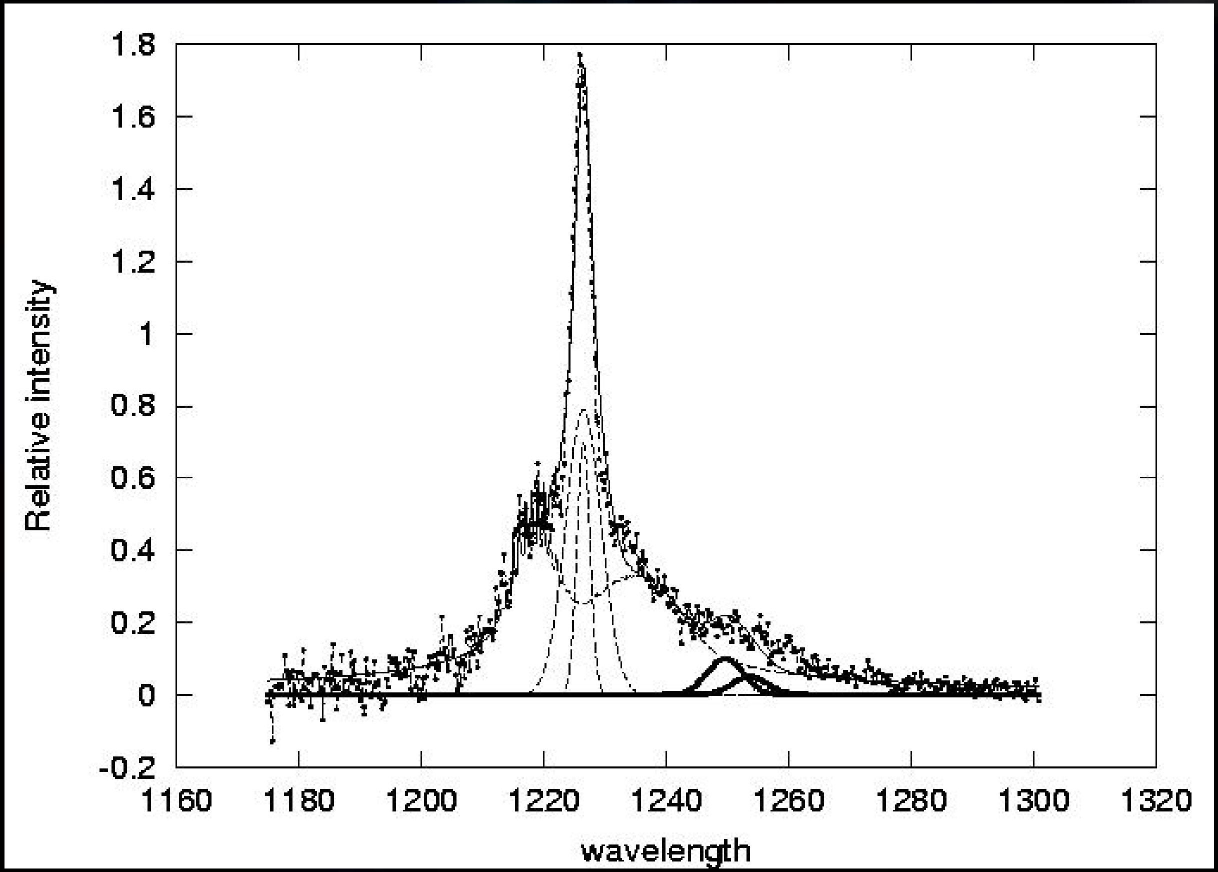
- Fe K line – disk emission + core line component (Nandra et al. 1999, ApJ, 523, L17; Turner et al. 2002, 574, L123)
- UV lines – two-component model: disk + spherical emitting region
- Balmer lines – two-component model (Popovic et al. 2002, A&A, 390, 473)

Fe K line (Turner et al. 2004)

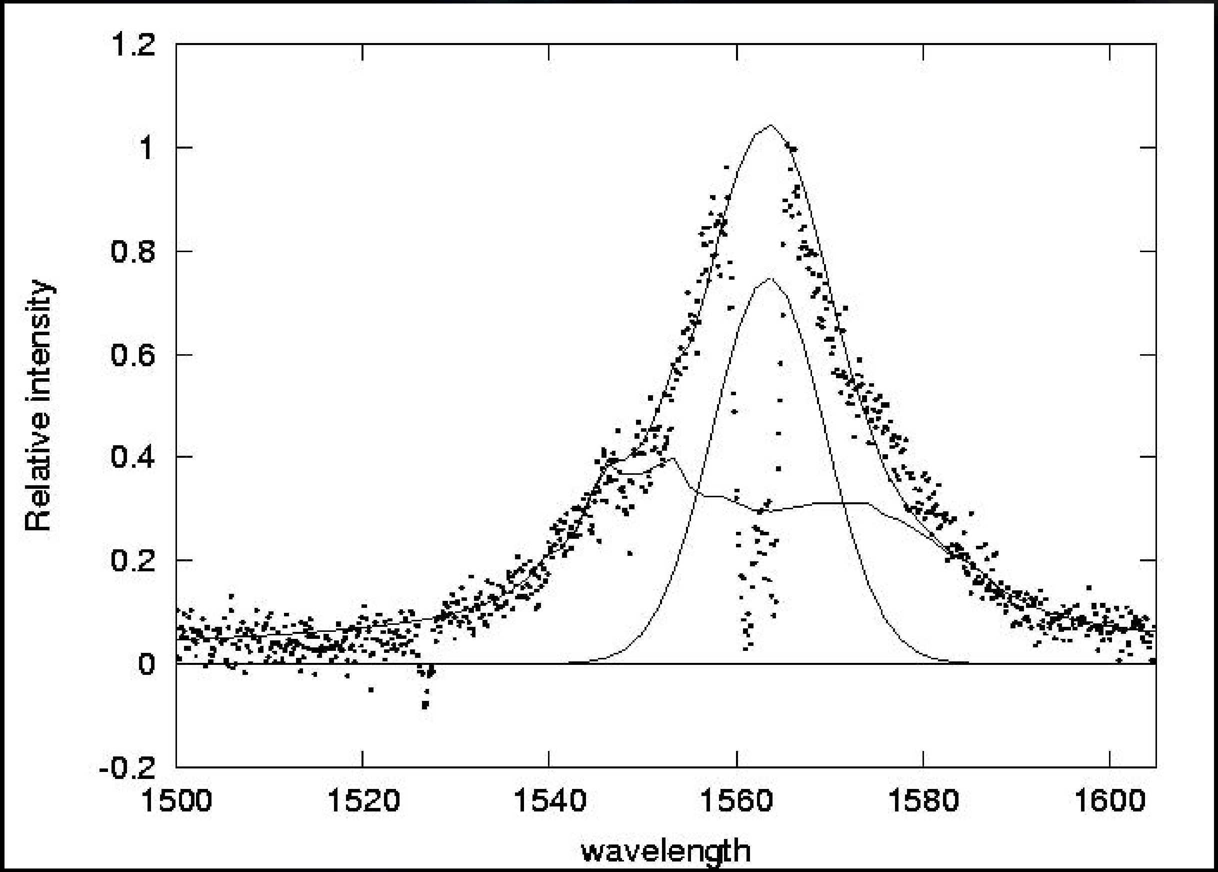




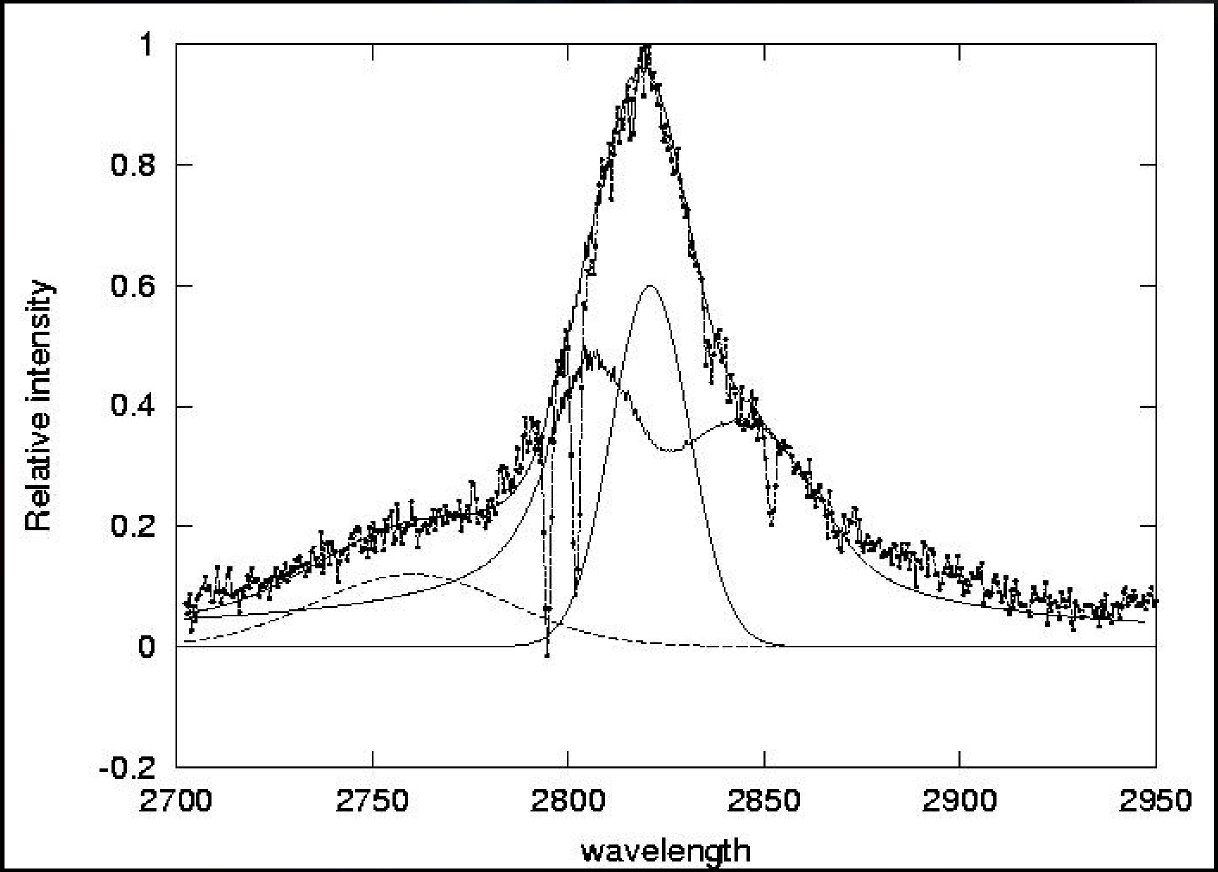
Ly-alpha (Popovic 2004, this conference)



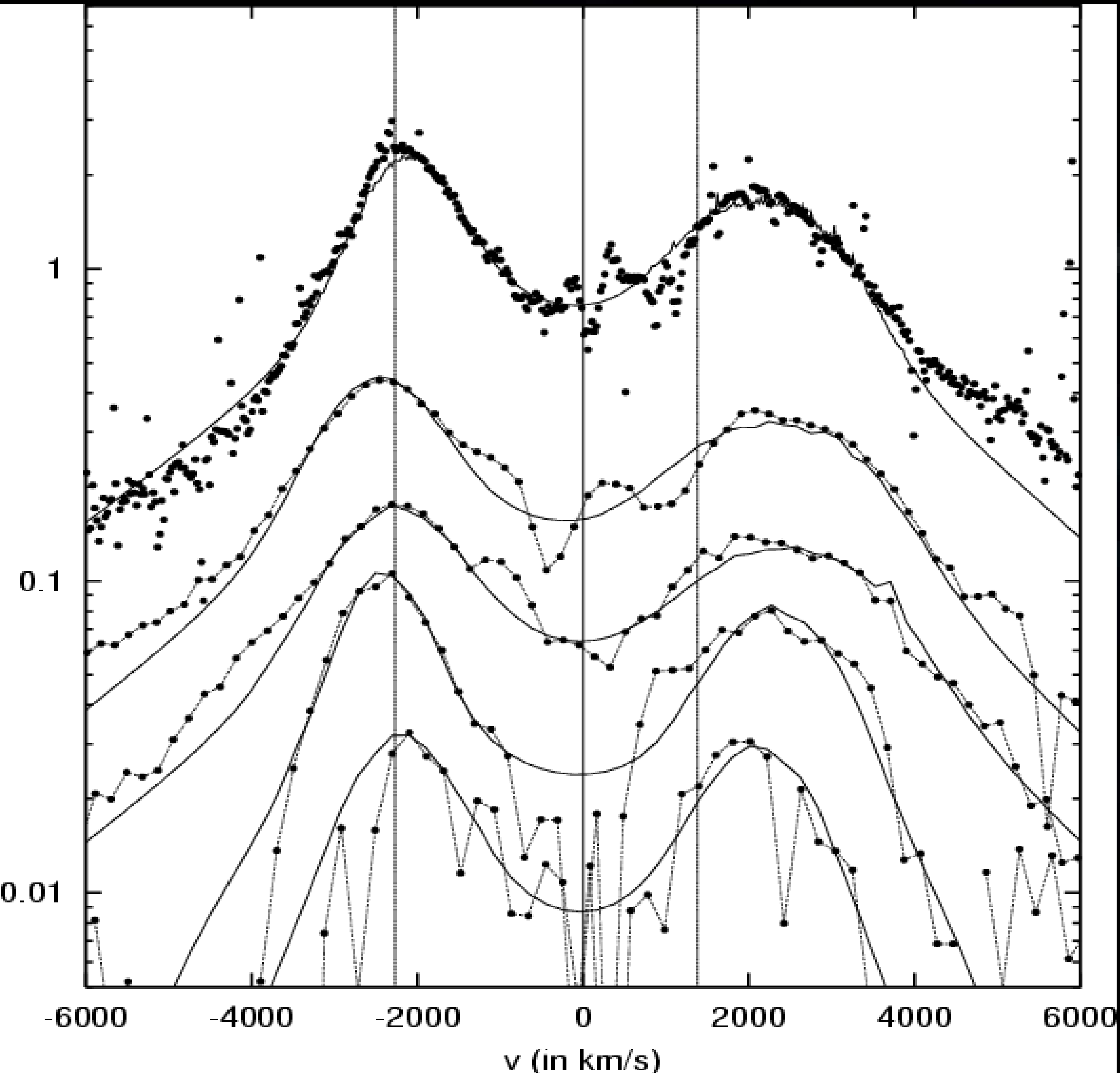
CIV line (Popovic 2004)

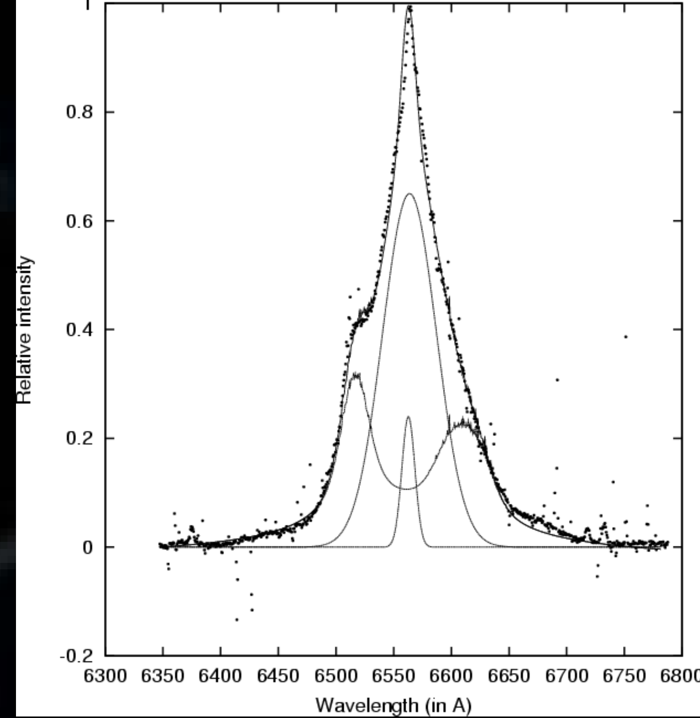


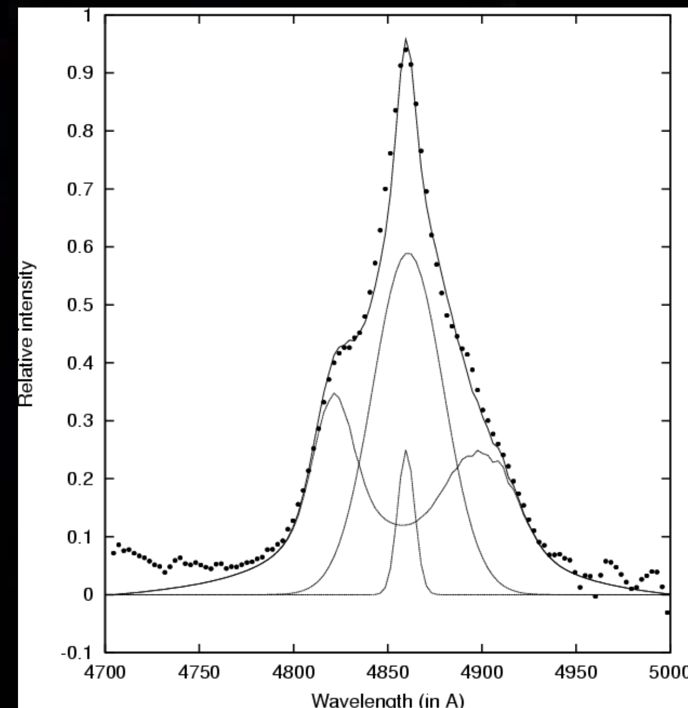
Mg II line (Popovic 2004)



Balmer lines (Popovic et al. 2002)



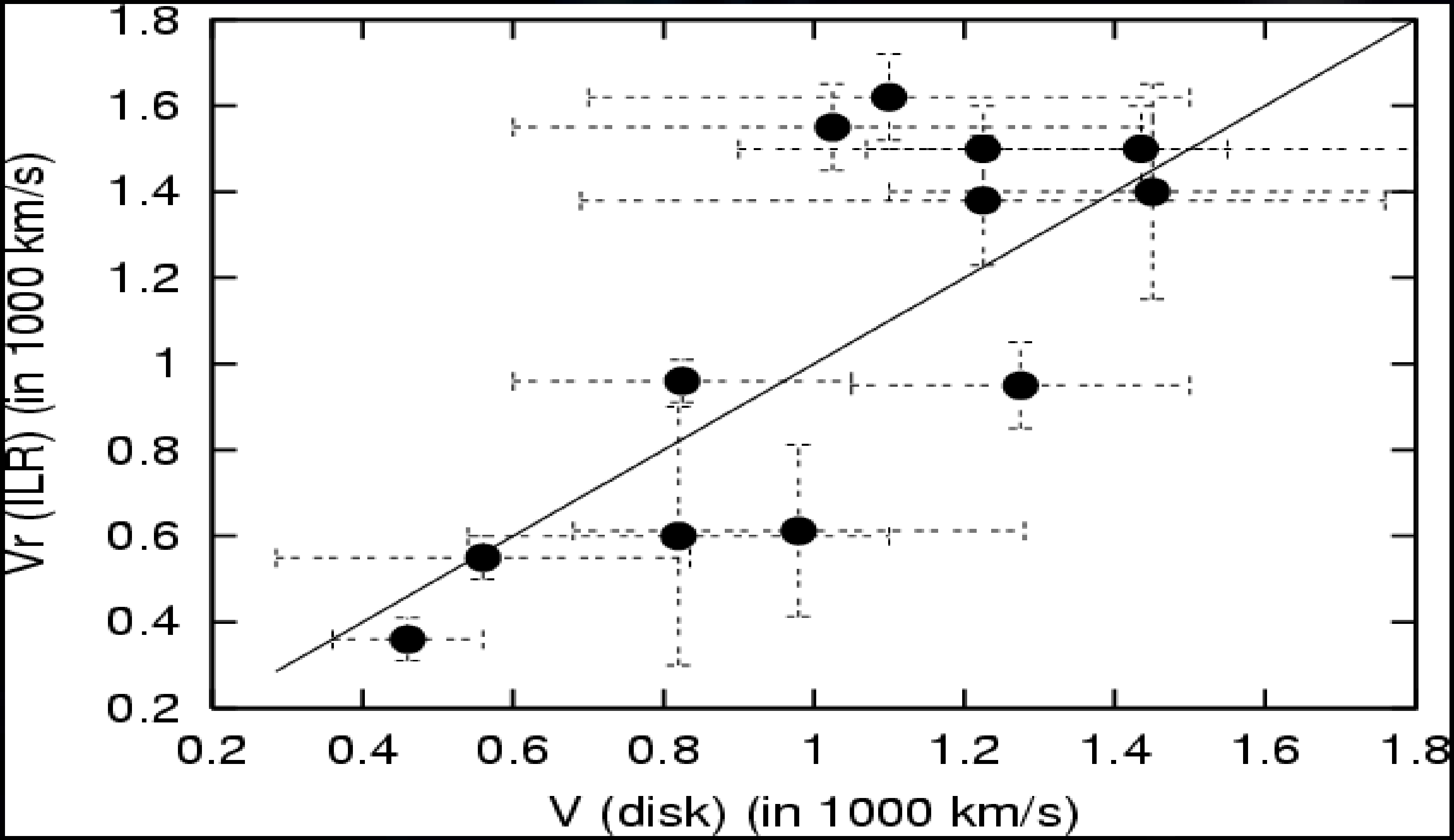




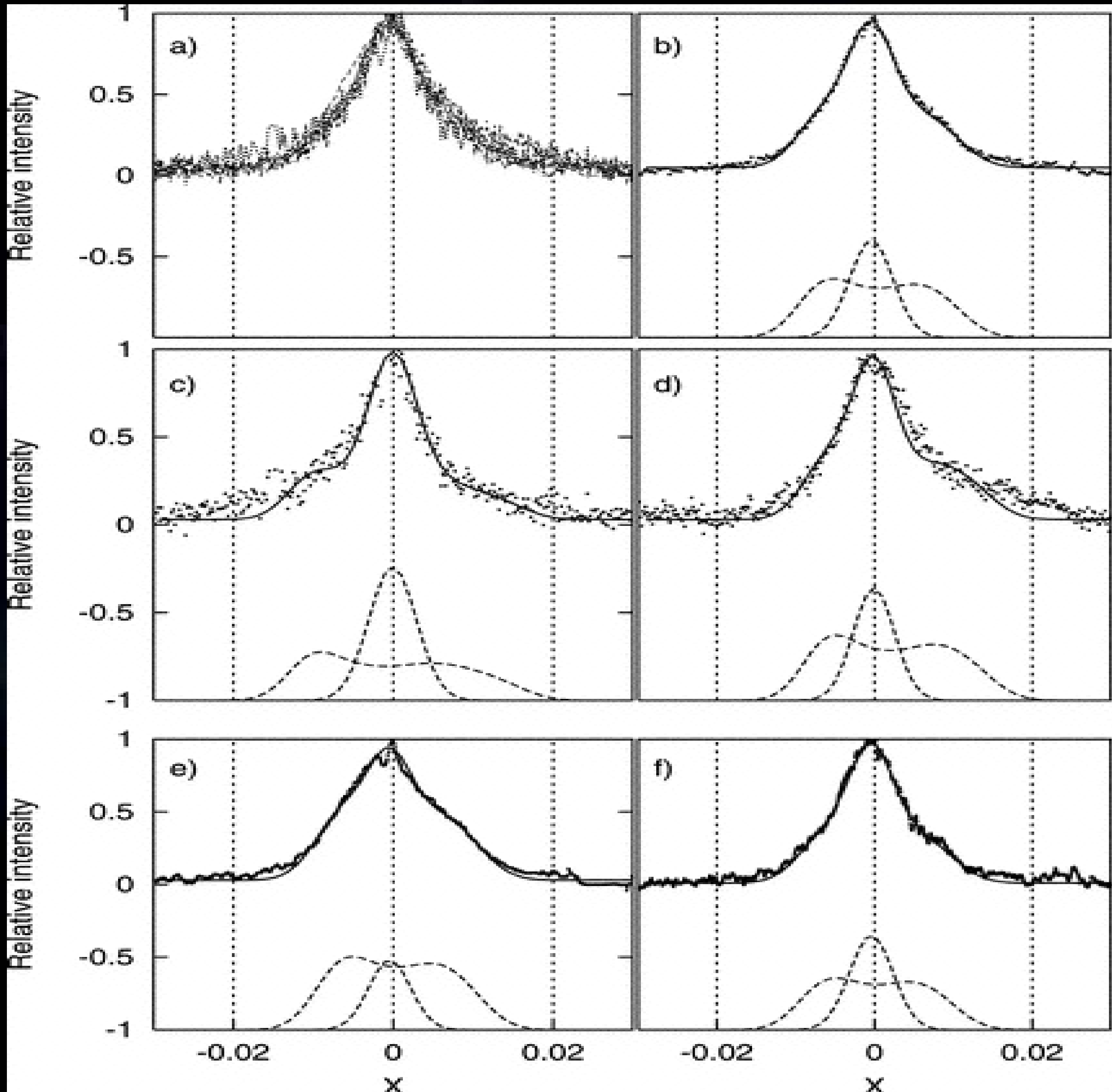
Some ideas

- Inner part – several tens of Rg => Fe K, i~0-19degrees (Nandra 1999)
- Several 100s of Rg to several 1000s Rg => broad UV/optical (i~11 degrees)
- The core component of the Fe K and UV/optical lines?

Velocity correlation between the disc and line core componets (Popovic et al. 2004)



III Zw 2



a)
b)
c)
d)
e)
f)
Relative intensity
Relative intensity
Relative intensity
1
0.5
0
-0.5
-1
-0.02
0
0.02
x

Stratification in BLR (Popovic et al. 2003, ApJ, 599, 185) – III Zw 2 (i~12 degree)

TABLE 1
PARAMETERS OF THE DISK

Line	z_{disk}	σ (km s^{-1})	R_{inn} (R_g)	R_{out} (R_g)	z_G	W_G (km s^{-1})	F_D/F_G
Lyα	−800	850	200	900	−20	1280	1.11
Mg II λ2789	−350	920	300	1000	−30	1100	1.86
Hβ	−600	920	400	1300	−130	1100	3.14
Hα	−600	850	450	1300	−120	1170	1.52
$\langle AV \rangle$	−600	890	400	1200	−120	1170	1.72

NOTES.—Explanation of symbols: z_{disk} is the shift, σ is the Gaussian broadening term from disk indicating the random velocity in disk, R_{inn} is the inner radius, and R_{out} is the outer radius. The z_G and W_G represent the parameters of the Gaussian component. $\langle AV \rangle$ is an averaged profile (see Fig. 10*b*). F_D/F_G represents the ratio of the relative disk and Gaussian fluxes.

Conclusions

- Very similar geometry in all three regions:

1) Disk component

   - In some AGNs the disk emission is present also in the UV/optical emission (line wings)

   - The UV/optical lines are probably emitted by the outer part of the accretion disk, while the Fe K is coming from the inner part

2) Core component

   - Core line component of the Fe K and UV/optical lines is emitted out of the disk

Alexander von Humboldt

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