The hard X-ray observation of the Compton-thick Seyfert 2 galaxy Mrk 1210

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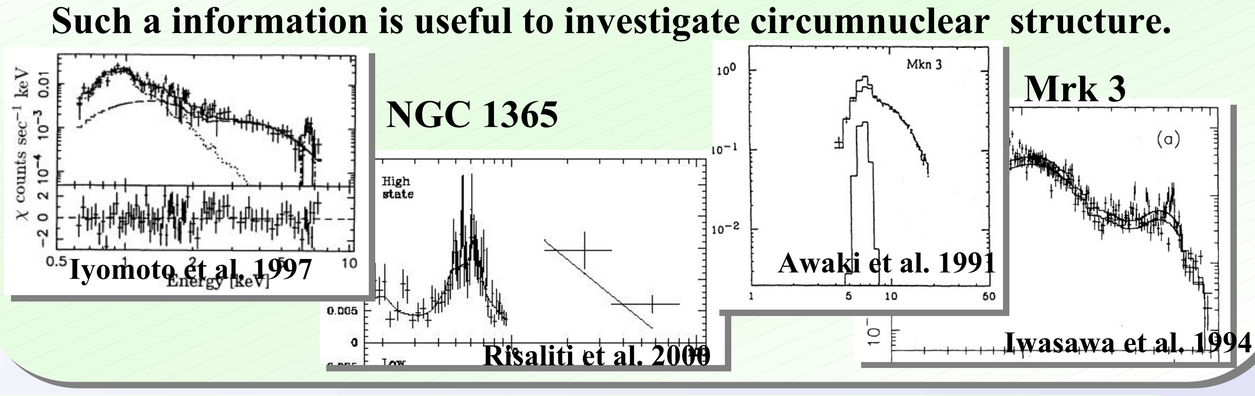
We observed Seyfert 2 galaxy Mrk 1210 with BeppoSAX, and found that the X-ray spectral properties are quite different from the previous observation by ASCA; the flux is significantly higher than that of ASCA and clear absorption cut-off was seen below 5 keV. A bright hard X-ray emission is detected up to 100 keV and we found the reflection component is necessary to describe the BeppoSAX spectrum. The reflection component flux is as high as that of the ASCA observation. This indicates that the dramatic spectral variability is attributed to a large change of the absorption column density by a factor of >5, rather than the variability of the nuclear emission. In this case, the torus is not be homogeneous but like a blob with a size of < 0.1 pc.

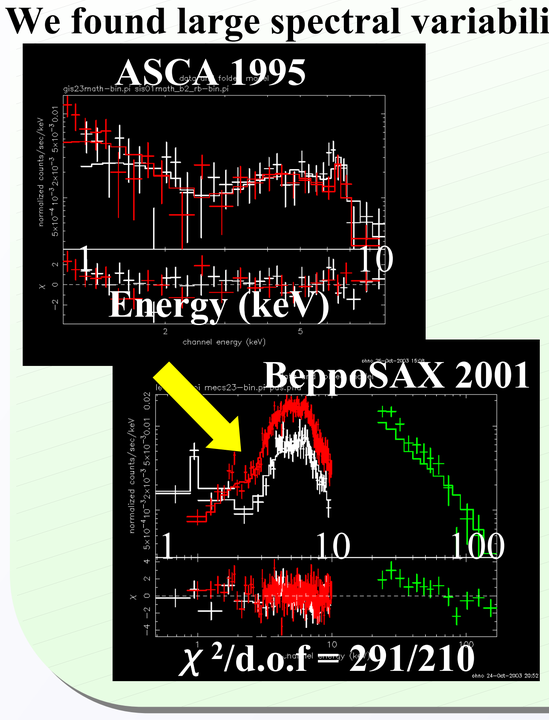
I. Ubiquitous spectral variability in Seyfert 2 galaxies

Recently, many Seyfert 2 galaxies reported that they have large spectral variability due to either change their luminosity or absorption. Such a information is useful to investigate circumnuclear structure.



II. Mrk 1210 dramatic spectral variability between the ASCA and BeppoSAX observation

We found large spectral variability



Absorbed P-L model

P-L + wabs × (P-L)

Soft component — Absorbed hard component

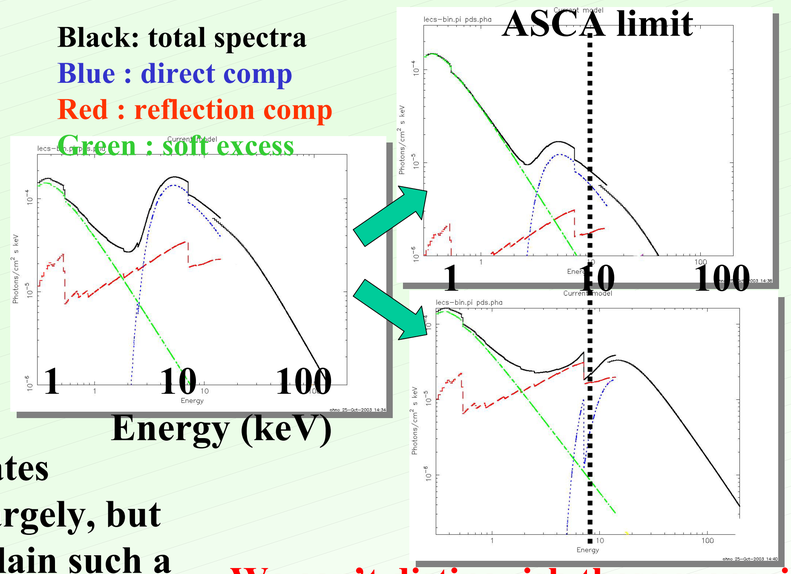
	ASCA	SAX
N_H (10^{22}cm^{-2})	2.24	2.29
L_X(10^{43} erg/s)※1	3.45	17.0
F_X (hard comp)※2	4.06	21.1
F_X(soft comp)※2	6.66	5.65

※1; absorption corrected 2 – 10 keV luminosity
※2 ; 2 –10 keV observed flux (10^{-12} erg/s/cm^2)

Absorbed power-law model indicates that the luminosity has changed largely, but there are other possibilities to explain such a dramatic spectral variability.

There are two possibilities to explain this variability

Black: total spectra
Blue : direct comp
Red : reflection comp
Green : soft excess



scenario 1
nucleus activity became quiet, and the intrinsic luminosity became weak.
the amount of change is more than factor > 6.
for example, Mrk 3.

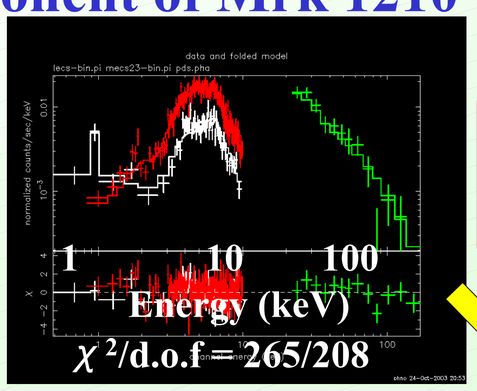
scenario 2
intrinsic luminosity is same but the absorption column density has changed at least an order of magnitude
for example, NGC1365.

We can't distinguish these scenarios because of limitation of energy band of ASCA !!

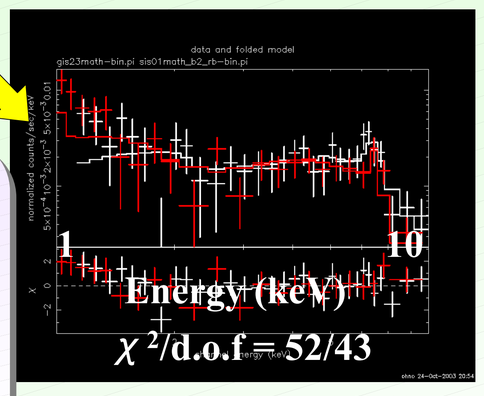
III. Compton reflection component of Mrk 1210

We can see the "bump" structure around 50 keV in the BeppoSAX spectrum.

This suggests that it is required Compton reflection component model. Thus, we applied Compton reflection model "PEXRAV" .



We tried fit the ASCA data using reflection parameter obtained by BeppoSAX results



Good Agreement !!

Compton reflection model

P-L + PEXRAV + 2gaussian + wabs × P-L

soft excess — refection component — line structure Fe-K and Fe-L — heavy absorption — nuclear emission

(※we fix Fe-L line energy to 0.93 keV)

Γ	1.86
R※1	1.86
Line E※2(keV)	6.39
E.W. (eV)	523
N_H (10^{22}cm^{-2})	20.4

※1 reflection fraction of PEXRAV
※2 Fe-K line energy and E.W.

The flat hard component of ASCA can be expressed by reflection component of BeppoSAX

⇓

The flat component of ASCA is also Compton reflection component of completely obscured nuclear emission? ; in this case, we estimate the absorption to be > 1.5 × 10^{24} cm^{-2}

The scenario of change of absorption (scenario 2) is preferable?

But we need wide energy band observation such as Astro-E2 HXD!

IV. Sturucture of the molecular torus

We estimate the distance from nucleus of torus to be < 1 pc using the maser data assuming simple Keplarian motion of torus around the nucleus with a mass of 10^7 $M_\odot$.
According this and the variability of spectral shape, we can impose some constrains on geometry of the torus

Scenario 1

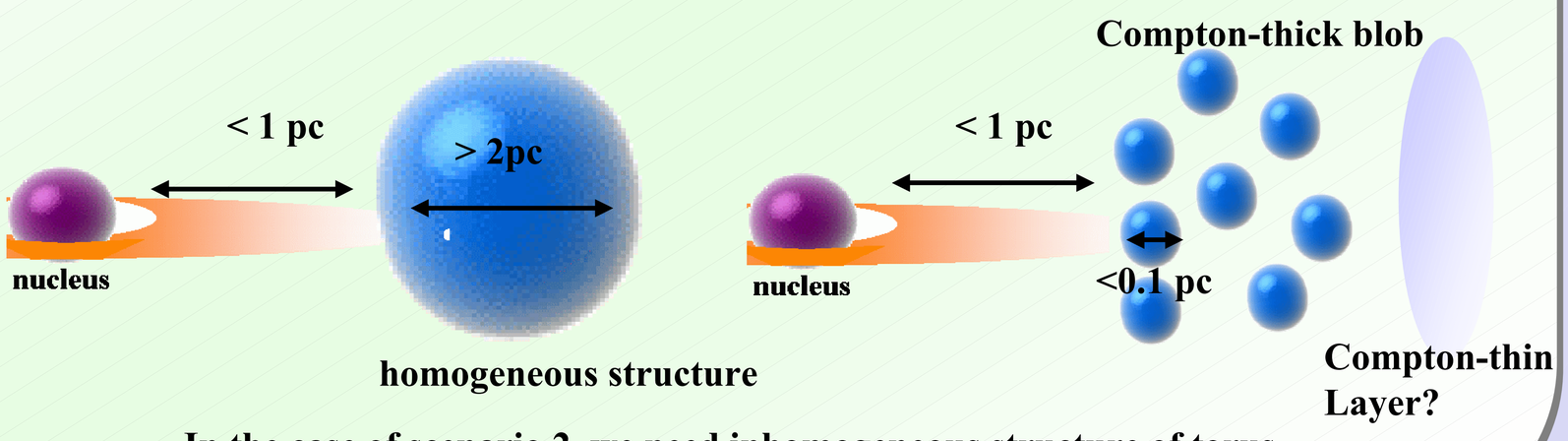
Absorption has not changed in 6 years,

⇒ size of molecular torus more than 2 pc

Scenario 2

Absorption has changed dramatically, and consider the rotation velocity of torus

⇒ the size of torus less than 0.1pc



In the case of scenario 2, we need inhomogeneous structure of torus
⇒ Expand unified model of AGN ?? (Matt. 2000)

V. Summary

- We found dramatic spectral variability of Mrk 1210 between ASCA and BeppoSAX
- To explain such a variability, we suggest two possibilities
  scenario 1: the nucleus luminosity has changed by the factor > 6
  scenario 2: the absorption column density have changed in an order of magnitude
  but we cannot distinguish these clearly
- According to the reflection component of BeppoSAX spectrum, scenario 2 is preferable.
- We can impose some constrains to the geometry of the molecular torus. In the case of scenario 2, we need inhomogeneous structure of torus.
  (Expand Unified Model of AGN?)