The warm absorber and UV-soft-excess continuum, a case study of IRAS13349+2438

SIBASISH LAHA

Inter University Centre for Astronomy & Astrophysics
(INDIA)

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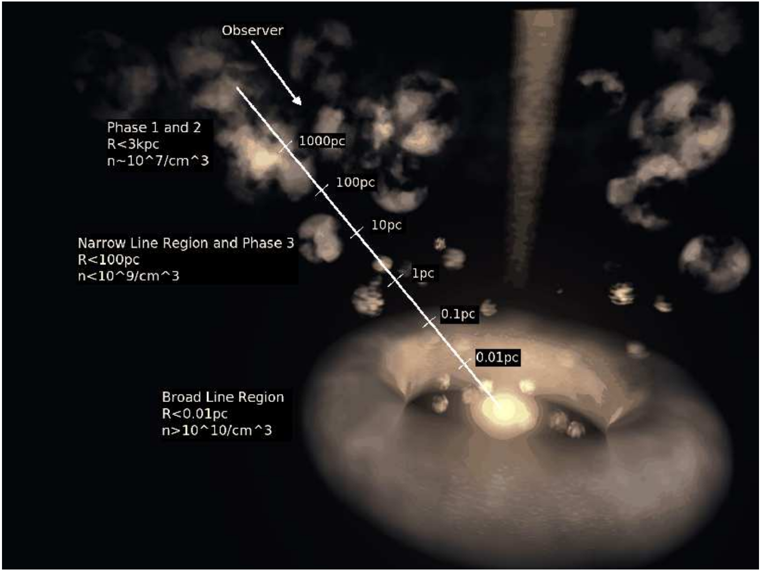
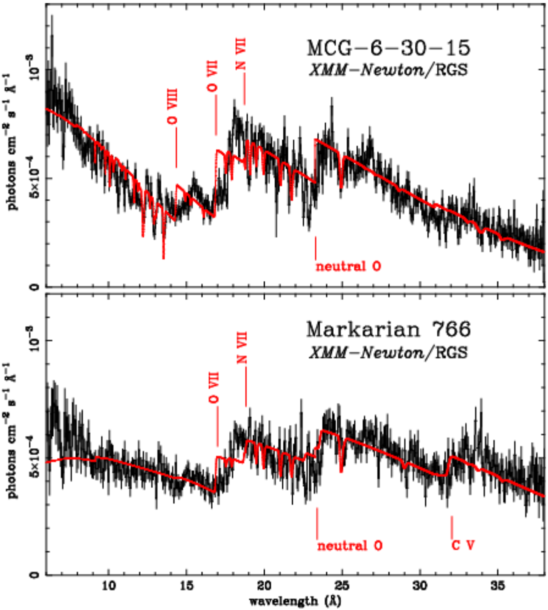
Thesis Supervisor: Ajit K. Kembhavi
Collaborators: Gulab Dewangan (IUCAA), Matteo Guainazzi (ESA)
Susmita Chakravorty(Harvard)

What are Warm absorbers?



Smith et al. 2008

- X-ray signatures of Warm absorbers...



Raymont et al. 2001

WA and the ionising photons

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- In this study we want to see if there is any difference in WA parameters for different input SED in CLOUDY.
- Since in many cases we just assume "some" SED in the UV, as it is unobservable due to Glactic extinction. Also in sample studies to maintain uniformity!

A case study

- To that effect we do a case study with a bright source IRAS 13349+2438

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- Previous studies done (Sako et al 2001)

The Soft-excess models used in our study

- blackbody
- nthcomp
- optxagn
- reflion

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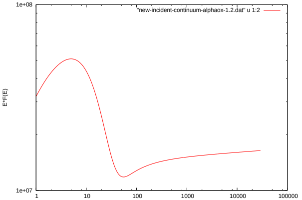
- In our preliminary study we used the general *Kirk Korista* continuum as the input continuum.
- And assumed the cloud hydrogen density to be similar to typical BLR density $\sim 10^9\ \mathrm{cm}^{-3}$



$$f_\nu = \nu^{\alpha_{uv}} exp(-h\nu/kT_{BB}) exp(-kT_{IR}/h\nu) + a\nu^{\alpha_x} \quad (1)$$

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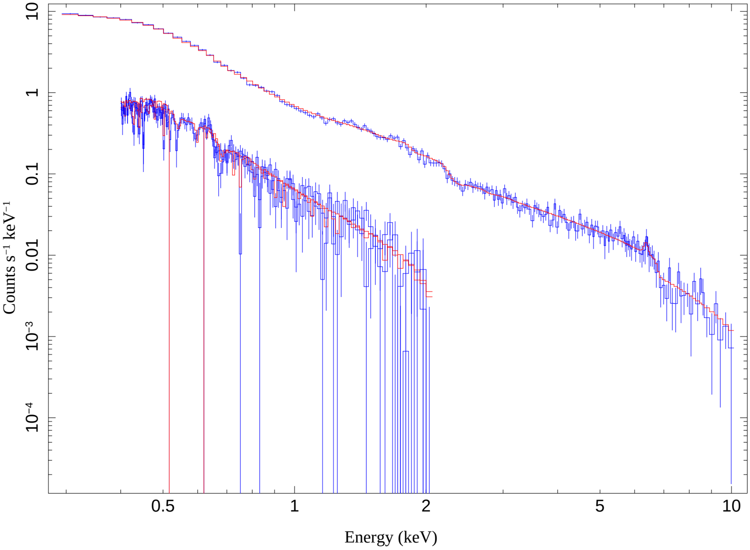
- The value of $\alpha_{\rm OX}$ is 1.2

Joint fit of EPIC-pn and RGS data of IRAS13349+2438



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- blackbody as SE
  - $\log(\xi) = 1.42^{+0.12}_{-0.10},\ 2.25^{+0.1}_{-0.09}$
  - $\log(N_{\mathrm{H}}) = 21.05^{+0.05}_{-0.05},\ 20.31^{+0.04}_{-0.05}$
  - $z = 0.1027 \pm 0.0001,\ 0.1035 \pm 0.0001$

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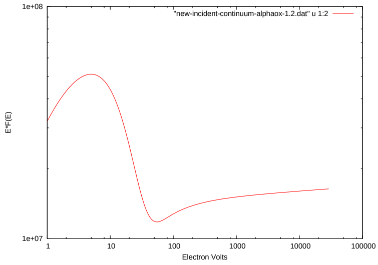
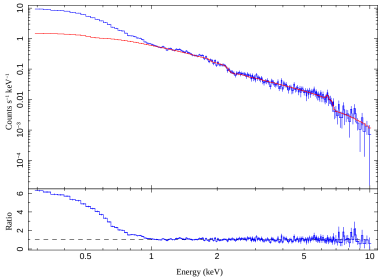
- optxagn as SE
  - $\log(\xi) = 1.48^{+0.05}_{-0.05},\ 2.23^{+0.06}_{-0.06}$
  - $\log(N_{\mathrm{H}}) = 20.80 \pm 0.09,\ 20.35^{+0.05}_{-0.12}$
  - $z = 0.1027 \pm 0.0001,\ 0.1035 \pm 0.0001$

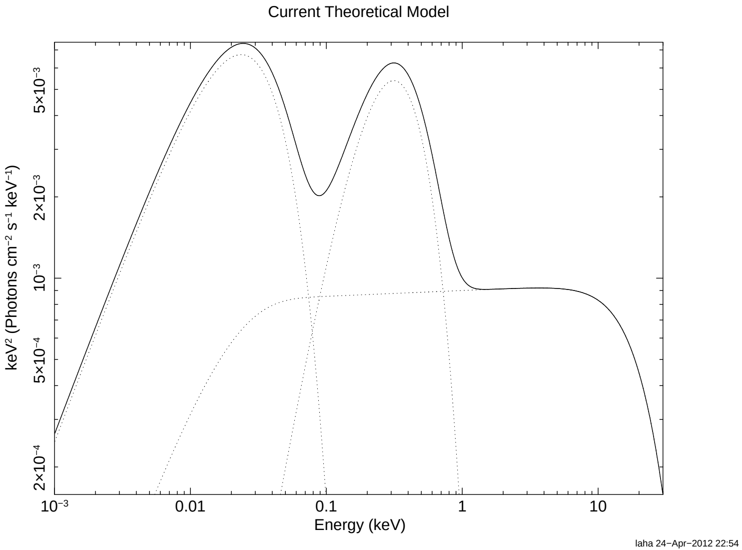
But Kirk Korista continuum is not realistic

- As we can see that it doesnot have a soft-excess! Even though we detect a prominent SE in the $0.3 - 2\ \mathrm{keV}$ range.
- So let's make a realistic continuum for this source, as seen by the Warm absorbers.





How do we make a 'realistic' continuum



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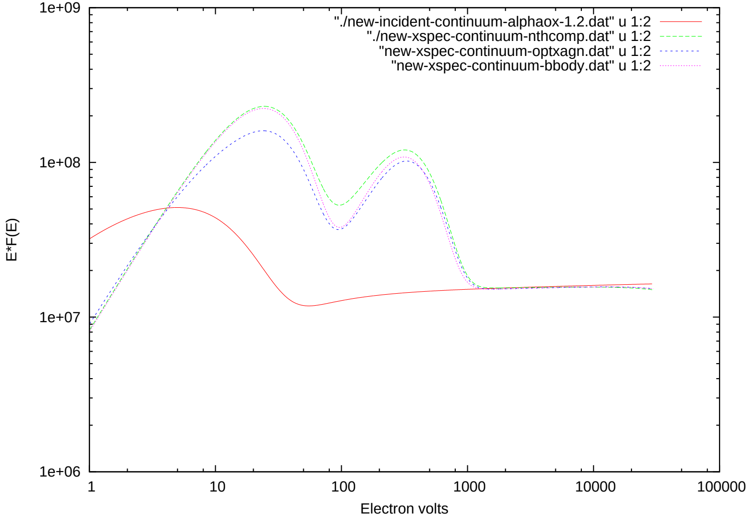

- A diskbb as the Big blue bump. Normalised with the observed flux at $\sim 6\ \mathrm{eV} \sim 2100\mathring{A}$

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  - $\log(N_{\rm H})= 20.99^{+0.05}_{-0.05},\ 20.54$
  - $z= 0.1027 \pm 0.001$
- nthcomp as SE
  - $\log(\xi)= 1.10^{+0.04}_{-0.12},\ 2.81^{+0.14}_{-0.3}$
  - $\log(N_{\rm H})= 21.10^{+0.05}_{-0.05},\ 20.16^{+0.05}_{-0.05}$
  - $z= 0.1027^{+0.0001}_{-0.0001},\ 0.1038^{+0.0001}_{-0.0001}$
- optxagn as SE
  - $\log(\xi)= 1.01^{+0.08}_{-0.15},\ 2.44^{+0.08}_{-0.05}$
  - $\log(N_{\rm H})= 20.84 \pm 0.05,\ 20.3$
  - $z= 0.1027 \pm 0.0001,\ 0.104$

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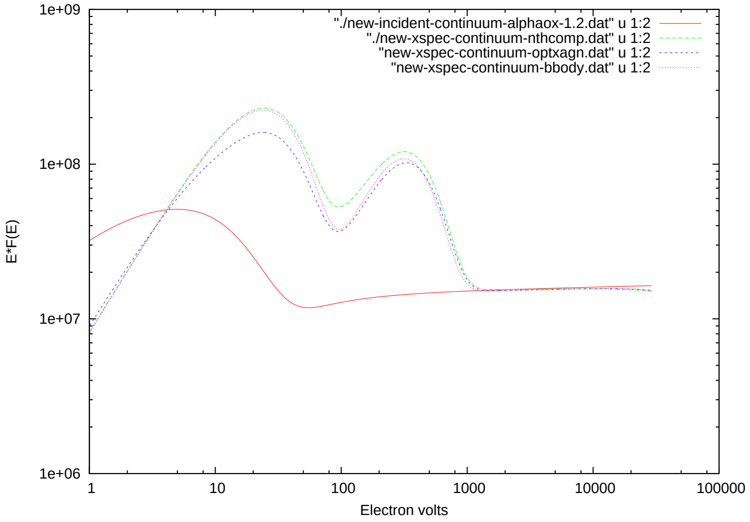
The ionisation states are different from those obtained previously.
It was $\log(\xi) = 1.42^{+0.1}_{-0.1}$, for bbody
Sako et al 2001 had obtained values similar to realistic case.

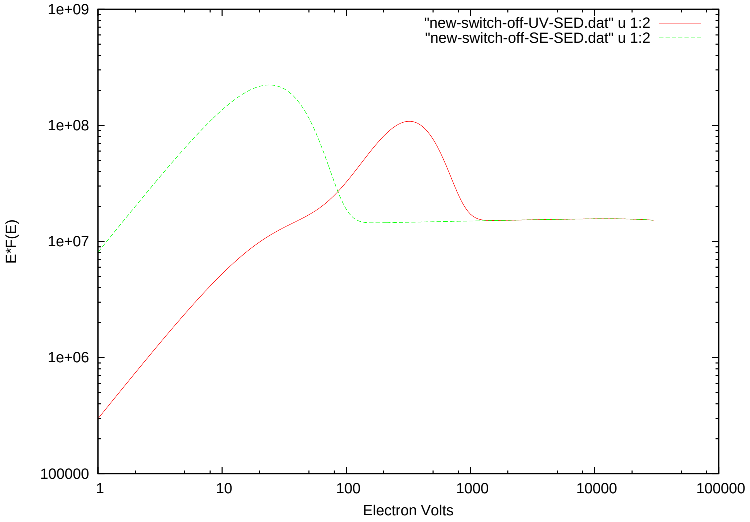
Realistic continuum



What is hapenning exactly?

- The models created by CLOUDY for the warm absorbers depend on the input continuum Flux as well as shape.
- The ionisation structure of the cloud is affected by the input continuum shape from 13.6 $\mathrm{eV} - 1\ \mathrm{keV}$
- Due to Galactic extinction the region 13.6 $\mathrm{eV} - 100\ \mathrm{eV}$ of the continuum of the source is unknown. Hence we talk about α_{OX} .
- The concept of α_{OX} is very deceptive. It does not specify any shape of the continuum between 2100$\AA$ and2 keV.
- Hence we should only use a 'realistic' continuum in generating warm absorber models, or else we may end up getting different values.

Switch off the Soft excess, and UV parts alternately



Results of the analysis

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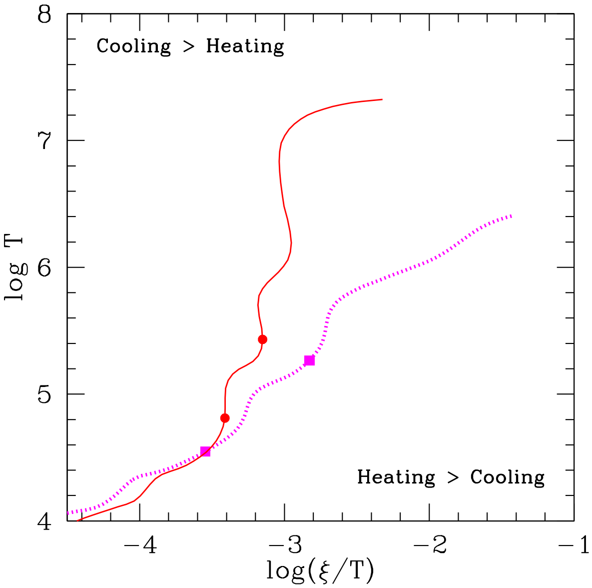
- UV SED switched off
  - $\log(\xi) = 0.60 \pm 0.1$
  - $\log(N_{\mathrm{H}}) = 20.90 \pm 0.06$
  - $z = 0.1027 \pm 0.001$
- X-ray SED switched off
  - $\log(\xi) = 1.75 \pm 0.09$
  - $\log(N_{\mathrm{H}}) = 21.09 \pm 0.05$
  - $z = 0.1027 \pm 0.001$

Note the difference in the ionisation states. The fit statistics isa little worse in case of the former.

The Stability curve analysis.



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- The UV and soft X-ray photons affect the warm absorbe models generated using CLOUDY. The ionisation structure is different for different continua, even when the ionising Luminosity is same.
- Hence a 'realistic' continuum model with properly normalised UV and soft X-ray flux should be used.
- A deeper study with S curve analysis would rule out certain continua for certain sources

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Thank you.