The Warm Absorber of the Seyfert Galaxy NGC5548

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ABSTRACT

We present a spectral analysis of the Seyfert 1 Galaxy NGC 5548 data, which were obtained by *CHANDRA* with HEGT and LEGT, adding a total exposure time of 800 ks. The warm absorber of NGC 5548 was modeled with the code PHASE. We detected two different outflow velocity systems in the absorption lines present in the spectra of this source. One of the absorbing systems has outflow velocity of -1091 ± 63 kms^{-1} and the other of -568 ± 49 kms^{-1}. Each system required two absorption components with different ionization level to fit the observed features. Each velocity system is consist of a multi-phase medium.

THE WARM ABSORBERS

In 50% Seyferts 1 and Quasars there are intrinsic absorption lines with a blueshift ~-100 to -2500 kms^{-1} with respect to the AGN host rest frame. This phenomenon, observed in the X-ray band, is caused by warm ionized gas (10^4-10^6K). The absorption lines are, between others, caused by the different transitions of Oxygen (O_{VI}, O_{VII}, O_{VIII}), or the different transitions of Iron ($Fe_{VII-XII}$ and $Fe_{XVII-XXII}$). This phenomenon is observed in the spectrum of NGC 5548.

NGC5548.

The Sy 1 Galaxy NGC5548 is at z =0.01717 with L_{2-6kev}=2.016X10^{43} $ergs^{-1}$. It was observed by *CHANDRA* with HEGT and LEGT adding a total exposure time of 800 Ks.

Instrument	UT Start Date	Exposure Time (ks)
HRC-S(LETG)	1999-12-11 22:51	85.98
ACIS-S(HETG)	2000-02-05 15:37	82.32
HRC-S(LETG)	2002-01-18 15:57	169.68
HRC-S(LETG)	2002-01-21 07:33	171.02
ACIS-S(HETG)	2002-01-16 06:12	153.9
HRC-S(LETG)	2005-04-15 05:18	116.43
HRC-S(LETG)	2005-04-18 00:31	25.19

THE MODEL.

The continuum (in the spectral range between 0.4-8 KeV) was well represented by a power law (Γ=1.55) with the addition of a blackbody component (kT = 0.1KeV). The warm absorber of NGC 5548 was modeled with the code PHASE (See Fig.1). This code fits 3 free parameters to each absorption component in the spectrum: 1) $U=Q(H)/(4cn_HR^2)$- ionization parameter, where Q(H) is the rate of H ionizing photons, R is the distance to the source, n_H is the hydrogen density and c is the speed of light, 2) V_{outf} – outflow velocity, 3) N_H-equivalent hydrogen column density.

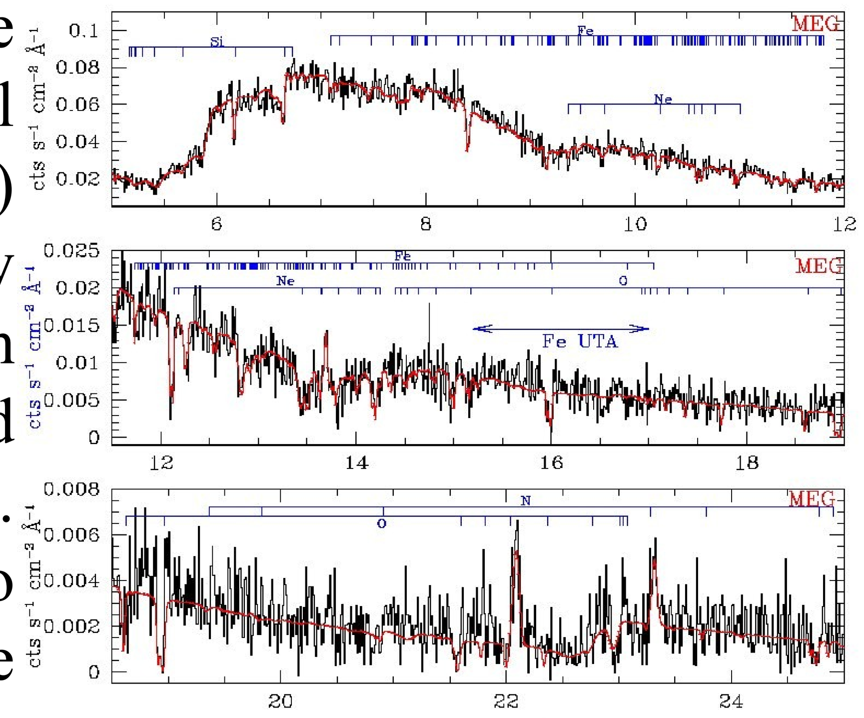

Fig. 1-Absorption lines produced by two-phase absorber model plotted against the first-order MEG spectrum of NCG5548. The lines predicted are marked in the top. The spectrum is presented in the rest-frame system of the absorbing gas.

RESULTS

We detected two different outflow velocity systems in the absorption lines present in the spectra of this source. For the system with V_{outf} =-568 kms^{-1}, one phase with logU = -0.52 contributes to the absorption by O_{VII-VI} and Fe M-shell UTA, while another phase with logU=0.67 contributes to the by Si_{XI-XIV}, Mg_{XI}, $Fe_{VII-XII}$ (See Fig.2).

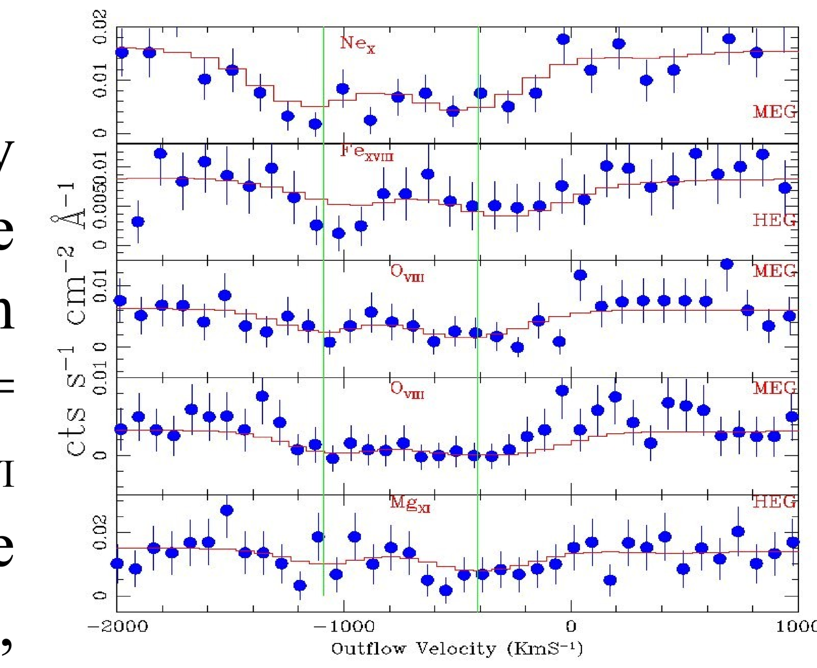

Fig.2- Absorption lines produced by Mg, O, Fe, and Ne ions, each one show the two velocity outflow systems of the absorber.

For the other system, V_{outf} = -1091 kms^{-1}, one phase with logU=0.74, produces absorption by Si_{XI-XIV}, Mg_{XI}, $Fe_{VII-XII}$, and another, with logU=1.26, contributes to the O_{VIII}, Ne X, Mg XII, $Si_{XIV-XVI}$.

Two Phase Absorber Parameter (high outflow velocity)		
Parameter	High-Ionization	Low-Ionization
Log U	1.26±0.05	0.74±0.09
Log NH(cm^{-2})	21.75±0.12	21.16±0.07
Vturb (kms^{-1})	102	124
Voutf (kms^{-1})	1091±63	1151±46
T (K)	2.99±0.72E6	7.8±1.1E5
Log T (K)	6.47±0.12	5.89±0.06
Log T/U	5.21±0.17	5.15±0.15

Two Phase Absorber Parameters (low outflow velocity)		
Parameter	High-Ionization	Low-Ionization
Log U	0.67±0.02	-0.52±0.09
Log NH (cm^{-2})	21.25±0.04	20.75±0.1
Vturb (kms^{-1})	192	100
Voutf (kms^{-1})	418±175	568±49
T (K)	5.3±1.5E5	3.5±0.15E4
Log T (K)	5.72±0.12	4.54±0.02
Log T/U	5.04±0.14	5.06±0.1

The two absorbing components that form each velocity system are in pressure equilibrium with the each other (See Fig.3).

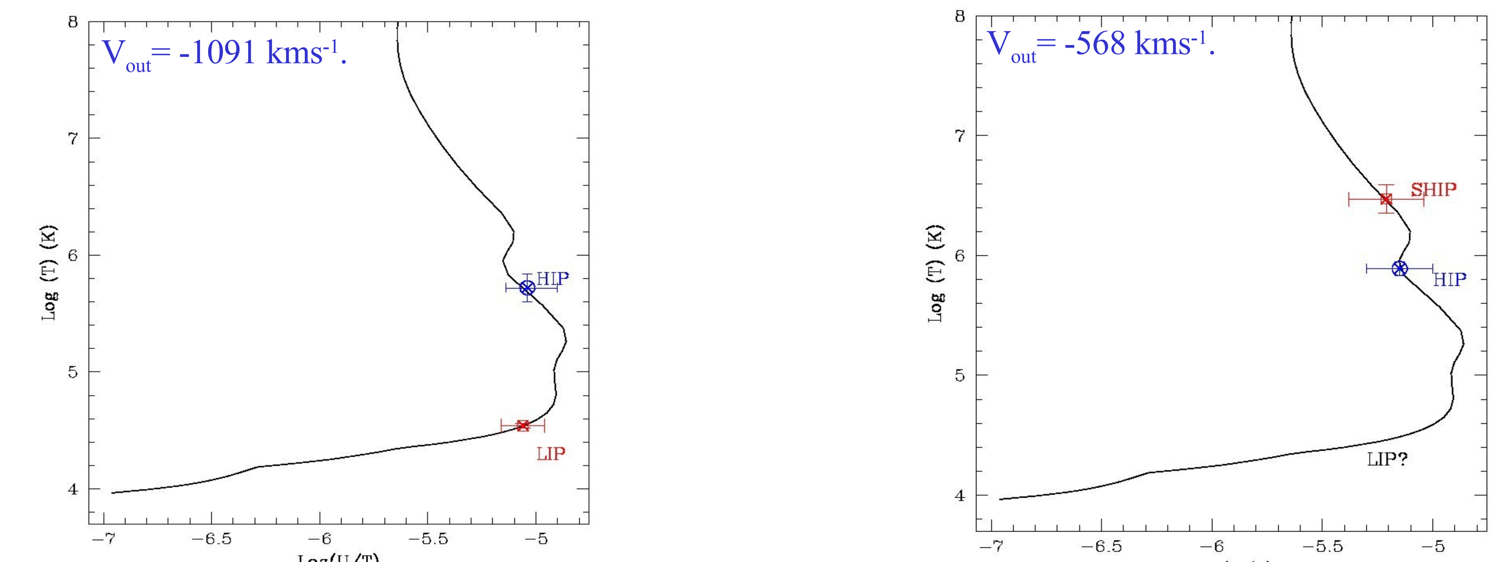

Fig.3- Curve of thermal stability for the SED used in this analysis. Both graphs show the two-phase absorber in pressure equilibrium. The HIP and the LIP have very different equilibrium temperatures but lie close to each other in the U/T axis. With the adopted definition of the ionization parameter U, this ratio is inversely proportional to P, the gas pressure. Hence assuming that the HIP and the LIP have the same location, the gas pressure between them is indistinguishable.

This suggests that each velocity system consists of a multi-phase medium. The kinematic components found on the X-rays are in agreement with the kinematic components forming the UV absorber. This supports the idea that the UV and X-ray absorption are part of the same phenomenon. The data do not require a model consisting of a continuos radial range of ionization structures, as suggested by a previous analysis. Such structure is actually ruled out, by the presence of similar charge states producing absorption with different outflow velocities.