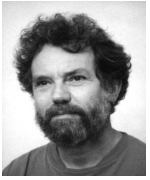

First analysis of the LETGS observations of Delta Orionis

A.J.J. Raassen (1,2) and A. Pollock (3)

(1) SRON Netherlands Institute for Space Research, Sorbonnelaan 2, 3584 CA Utrecht, The Netherlands

(2) Astronomical Institute "Anton Pannekoek", Kruislaan 403, 1098 SJ, Amsterdam, The Netherlands

(3) European Space Agency XMM−Newton Science Operations Centre, Apartado 50727, Villafranca del Castillo, 28080 Madrid, Spain

Email: a.j.j.raassen@sron.nl a.j.j.raassen@uva.nl

Abstract

We extend knowledge of the soft X−ray spectrum of the intrinsic wind emission from O−stars with a CHANDRA LETG observation of the O9.5II star delta Orionis with a duration of 100ks. This is the first viable high−resolution long−wavelength X−ray spectrum of any hot star.

Our first goal is to identify line features of cool (low−ionized) ions upto 80 Angstrom (Pollock 2007).

The second goal is a fit to the total spectrum applying different plasma models, such as a Non−Equilibrium (NEI) or a Collisional Ionization Equilibrium (CIE) model and to distinguish between them.

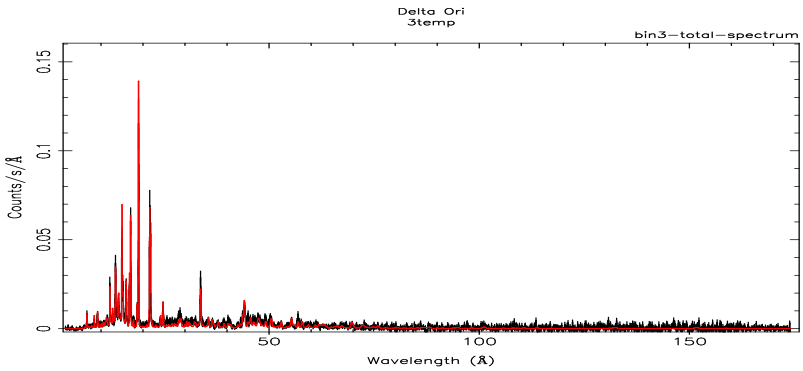

Fig 1. The fitted three temperature CIE model (red) and observed LETGS (black) spectrum of delta Ori.

Two fits to the spectrum have been made, one CIE and one NEI (see Table 1 and 2). Fig.1 shows the LETGS spectrum of delta Ori together with a three temperature fit applying a CIE model from SPEX. The fit results of the CIE and NEI model are given in Tables 1 and 2. The u−value (n t) in the NEI method is that high that this approach becomes identical to an equilibrium model.

Parameters	CIE	NEI
$\log\ N_H\ [\mathrm{cm}^{-2}]$	20.17	20.17
T_1 [keV]	0.096(.006)	0.094(.003)
T_2 [keV]	0.194(.008)	0.189(.004)
T_3 [keV]	0.584(.013)	0.574(.010)
$EM_1\ [10^{54}\mathrm{cm}^{-3}]$	2.00(.19)	1.78(.18)
$EM_2\ [10^{54}\mathrm{cm}^{-3}]$	3.02(.22)	3.03(.19)
$EM_3\ [10^{54}\mathrm{cm}^{-3}]$	3.10(.42)	3.48(.25)
$EM_{Tot}\ [10^{54}\mathrm{cm}^{-3}]$	8.12(.51)	8.29(.36)
$L_{X1}\ [10^{31}\mathrm{erg/s}]$	0.88	0.91
$L_{X2}\ [10^{31}\mathrm{erg/s}]$	3.84	3.70
$L_{X3}\ [10^{31}\mathrm{erg/s}]$	4.90	5.21
$L_{Tot}\ [10^{31}\mathrm{erg/s}]$	9.62	9.82

Tabel 1. Temperature and emission measure values for the CIE and NEI fit to the LETGS spectrum of delta Ori.

Parameters	CIE	NEI
C	0.91(.08)	0.86(.07)
N	0.88(.09)	0.83(.08)
O	0.62(.04)	0.61(.04)
Ne	0.69(.12)	0.59(.08)
Mg	0.71(.12)	0.64(.09)
Si	0.81(.08)	0.79(.07)
Fe	0.50(.04)	0.46(.04)
$u = n_e t [10^{11}\mathrm{cm}^{-3}\mathrm{s}]$	—	2.6(.3)
χ^2/d.o.f.	5832/4866	5769/4865
χ^2_{red}	1.20	1.19

Tabel 2. Abundances for the CIE and NEI fit to the LETGS spectrum of delta Ori.

The abundances are relative to solar values by Anders and Grevesse (1989) except for Fe, for which we used Grevesse and Sauval (1999).

The resemblance of the CIE and NEI fit will be investigated into more detail.

Apart from the 3−T fits a differential emission measure (DEM) modelling was made using the regularization method given in SPEX (Kaastra et al. 1996). The result is given in Fig. 2.

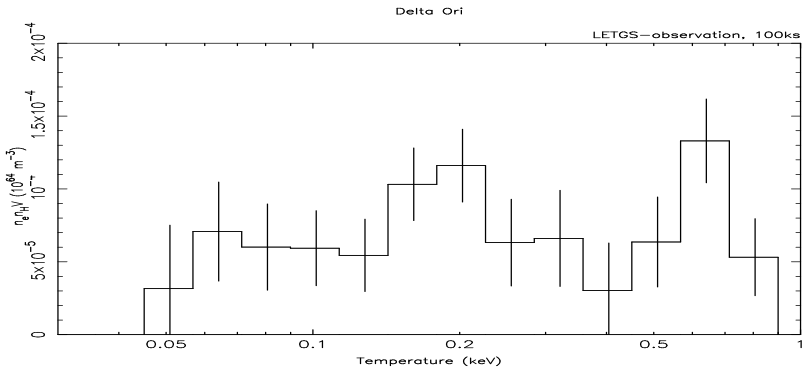

Fig 2. DEM of the LETGS spectrum of delta Ori.

References

Anders, E. & Grevesse, N., 1989, Geochim. Cosmochim. Acta, 53, 197

Grevesse, N. & Sauval, A.J., 1999, A&A, 347, 348

Kaastra, J.S., Mewe, R. & Liedahl, D.A., 1996, A&A, 314, 547

Pollock, A.M.T., 2007, A&A, 463, 1111

SRON Netherlands Institute for Space Research

UvA, University of Amsterda