The galactic supersoft x-ray source RXJO925.7-4758(MR vel)

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ABSTRACT

Close binary supersoft X-ray sources (CBSS) are believed to be an accreting white dwarf (WD) in a close binary with near-main-sequence companion, which can provide large mass accretion rates ($1*10^{-7} - 6*10^{-7} M_{\odot}$ yr-1). During such high accretion rates, hydrogen shell burning consumes hydrogen at the same rate as the WD accretes. Using most recent proton capturing reaction rates and beta-decay rates the cyclic reactions have been studied. In the present work, effort has been made to explain the observed characteristics of the source RXJ0925.7-4758 considering the above mentioned model. The calculated values of Luminosity ($8.56*10^{37}$erg/sec) and Effective temperature (94.19 eV) tally well with the observed ones. The Color temperature of RXJ0925.7- 4758 near the photosphere has been determined as 106 eV. Photo ionisation code CLOUDY has been used to explain the observed absorption edges in the spectrum of RXJ0925.7-4758. Key words: White Dwarf, Supersoft X-ray sources, Color temperature, Absorption edges.

MODEL CONSIDERED:

In order to explain the observed characteristics of RXJ0925.7-4758, a steady state model Nomoto etal (2007) is considered[4].

Table 1 MODEL PARAMETERS:

Steady state Hydrogen burning model, WD mass M=1.35$M_{\odot}$

$\dot{M}$ ($M_{\odot}yr^{-1}$)	3.5×10^{-7}
$Log_{10}T_H$ (K)	8.05
T_H (K)	$0.11\times10^{+9}$
$Log_{10}\rho_H$ (gm/cm^3)	1.56
ρ_H	36

COLOR TEMPERATURE:

In the layer of optical depth τ < 1, photon flux is transmitted with out loss of energy , although individual photons are scattered many times[6]. Hoshi (1998) approximates these layers with τ≤ 2/3 to be isothermal with the temperature T_{color}, the temperature at τ =2/3 . The Color temperature T_{color} is given by the relation,

$$T_{color} = (k_a k_e T^{-4}/\rho)^{-1/7} \, (k/\mu m_H)^{-1/7} \, (L/L_{e,Edd})^{3/7} * (1 - L/L_{e,Edd})^{-1/7} (3/a)^{3/7} (GM/R^2)^{2/7}$$

Where k_e and k_a are electron scattering opacity and absorptive opacity, m_H is the mass of the hydrogen atom and μ is the mean molecular weight respectively.

Gas density near the photosphere is so low that the electron scattering opacity dominates over the absorptive opacity[7]. k_e and k_a near the photosphere is 0.33 cm^2/gm and 0 .0738 cm^2/gm respectively. With the radiation density constant $a = 7.56*10^{-15}$ erg cm^{-3}K^{-4} , T_{color} is $1.06*10^2$ ev.

ABSORPTION EDGES:

The sss RXJ0925.7-4758 shows absorption features at 532.12 ev,706.86ev and 867.22ev .(8). Using the one dimensional photoionization code CLOUDY 2013(9) , we aim to understand the physical conditions around the compact object by modelling these absorption features with physical parameters. The simulation has been done by varying radius from (10^{12}-10^{18})cm. The graphs are shown in figure bellow. In the graph hden is the log of hydrogen density, NH is log value of hydrogen column density and radius is the log value of distance from the source.

METHODOLOGY ADOPTED:

Simulating absorption edges

1. By varying Hydrogen density, 2. By varying radius, 3. By varying Abundances

RESULTS

In simulation ,by varying different parameters,three absorption edges are obtained. The position of the edges tally well with the observed values by XMM newton.[8].For varying radius, no absorption edges are obtained at a distance less than 10^{12}cm and greater than 10^{18}cm.Therefore it can be remarked that the cloud size is from 10^{12}cm to 10^{18}cm being the other parameters fixed. By varying hydrogen density(hden),at low density (10,100 cm^{-3}) only absorption features are obtained but in the density range from(10^3cm^{-3} to 10^9cm^{-3}) emission features are obtained along with absorption features. As the observed spectra of RXJO 925.7 shows emission features ,so it can be concluded that the density of the cloud in the range from (10^3cm^{-3} to 10^9cm^{-3}).Simulation with ISM abundance ,in the low density ISM only two absorption edges are obtained. Therefore it can be concluded that the source is located behind a dense cloud.

INTRODUCTION

X-ray emission has been observed from all kinds of celestial objects. Some X-ray sources are exist in binary system. The Einstein observatory discovered a new class of X-ray binaries named as Luminous supersoft X-ray sources (SSS) [1]. The first supersoft X –Ray source was discovered in the Magellanic cloud [2]. SSS are associated with cataclysmic variables(CVs), symbiotic stars and post outburst optical novae[3]. They have extremely soft spectra (equivalent blackbody temperatures of 15–100 eV) and are highly luminous (bolometric luminosities of 10^{36}–10^{38} erg s^{-1}). In the present work SSS RXJO925.7-4758, has taken for the study of absorption edges, luminosity, effective temperature and color temperature.

METHODOLOGY ADOPTED

The Equations used

$E_{nuc} = QR_{12}/\rho$ erg g^{-1}s^{-1}

$= Q \rho N_A [N_A \langle \sigma \upsilon \rangle X_H X_Z f_S] / A_1 A_2$ erg g^{-1} s^{-1}

Here, R_{12} is the slowest reaction rate and Q is the total disintegration energy in the cycle. N_A is the Avogadro number. A_1 and A_2 are the mass numbers of the reacting nuclei of the slowest reaction rate, f_S is the enhancement factor . Energy radiated per second that is luminosity L is given by, $L = E_{nuc}$ Mergs^{-1} , $M = \dot{M} t_{acc}$,

where $\dot{M}$ is the mass accretion rate and t_{acc} is the time of accretion . The effective temperature is given by

$T_{eff} = (L/4\pi R^2 \sigma)^{1/4}$

Where R is the radius and б is the Stefan-Boltzmann constant.

From [5] recent reaction rates are taken for mathematical calculations.

CALCULATED AND OBSERVED VALUES

Table 2 Here, T_9 =0.11K, ρ =36 gm/cc, accretion rate=6.97×10^{27}gm/year

Supersoft X-ray sources	Observed luminosity(L)erg/sec	Observed Effective temperature (T_{eff}) ev	Calculated luminosity(L)erg/ sec	Calculated Effective temperature (T_{eff}) ev
RXJ0925.7-4758	5×10^{37}	96	8.56×10^{37}	94.19

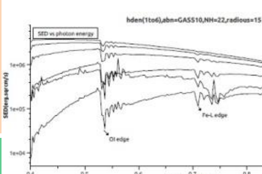

Fig (a)

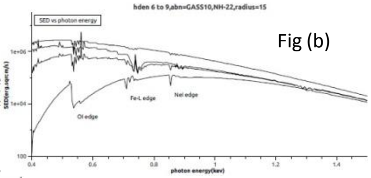

Fig (b)

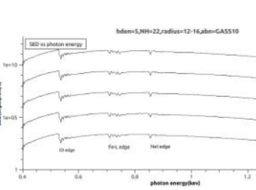

Fig (c)

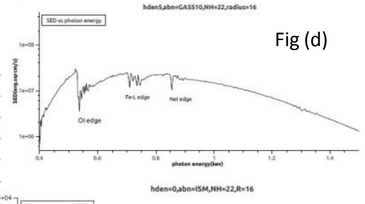

Fig (d)

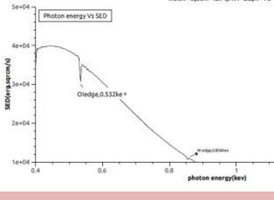

Fig (e)

Position of absorption Edges by varying hden Fig (a): 1-6, Fig(b):6-9 , Fig (c): radius 12-16, Fig (d): hden 5, best fit parameters for the absorption edges, Fig(e): Low density ISM.

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