
"Per aspera ad astra..."

Contents

Introduction	2
1 Introduction to the stars in high energy	3
1.1 Motivation	4
1.2 Observations	5
2 Cataclysmic variable stars	6
2.1 Non magnetic cataclysmic variables	6
2.2 Magnetic cataclysmic variables	6
2.2.1 Polars	6
2.2.2 Intermediate polars	6
2.3 Galactic population of cataclysmic variables	6
2.4 Others important creatures	6
2.5 GXRE	6
3 Model of post shock region	7
3.1 Thermal bremsstrahlung	7
3.2 Post shock region	7
3.3 WD mass estimations methods	7
4 Data analysis	8
Bibliography	9
Apendix	10

Introduction to the stars in high energy

Let your imagination soar. By sitting on the old rocker looking at the sky with couple of good old whiskey you can easily start thinking about the universe. You are looking at a heck of a different kinds of cosmic objects, but suddenly you see almost only the stars. Almost all the shiny dots on the sky are stars and these stars are only the closest ones. Yes, you can see few other galaxies by naked eye¹, but none of the exotic cosmic objects you are imaging about. They are too faint to be observed easily, because they are not only far, far away, but also usually shines on different wavelengths, not visible by human eye.

Think about distances in the universe. One of the most accurate explanation is that from: Adams (1979) *"Space," it says, "is big. Really big. You just won't believe how vastly, hugely, mindbogglingly big it is. I mean, you may think it's a long way down the road to the chemist's, but that's just peanuts to space..."*

Consider this, sometimes you want to study processes in these extreme, very faint objects, but they are too faint and too far in the universe. You are looking for "laboratory" with similar processes, but located much closer to the observer. The X-ray binary stars can be this kind of laboratories.

There is, off-course, many interesting phenomena which could be studied in X-ray binaries or in non-binary X-ray stars. Several of them are mentioned in motivation section.

I am mentioning many interesting things in this work, but main effort is taken to study post shock region in Intermediate Polars.

¹M31 and M33 in extremely good conditions on northern hemisphere and Magellanic clouds on southern one

1.1 Motivation

We easily find many reasons why to study stars in high energy bands. We can consider the direct and the most common scientific applications like observations of the supernovae, black holes & neutron stars in X-ray binaries. But for education purposes I am preferring several others, very nice examples closer to topic of this work.

- **Relativistic jet phenomena:** like it was proposed by Mirabel (2002) that universal mechanism should be at work in all the relativistic jet sources in the universe. Better understanding of sources as: microblazars, AGNs and gamma-ray burst will helps to gain more comprehensive understanding of this phenomena. Microblazars can play role of “space laboratories”, where interesting processes last on different timescales as in the case with AGNs or GRBs.

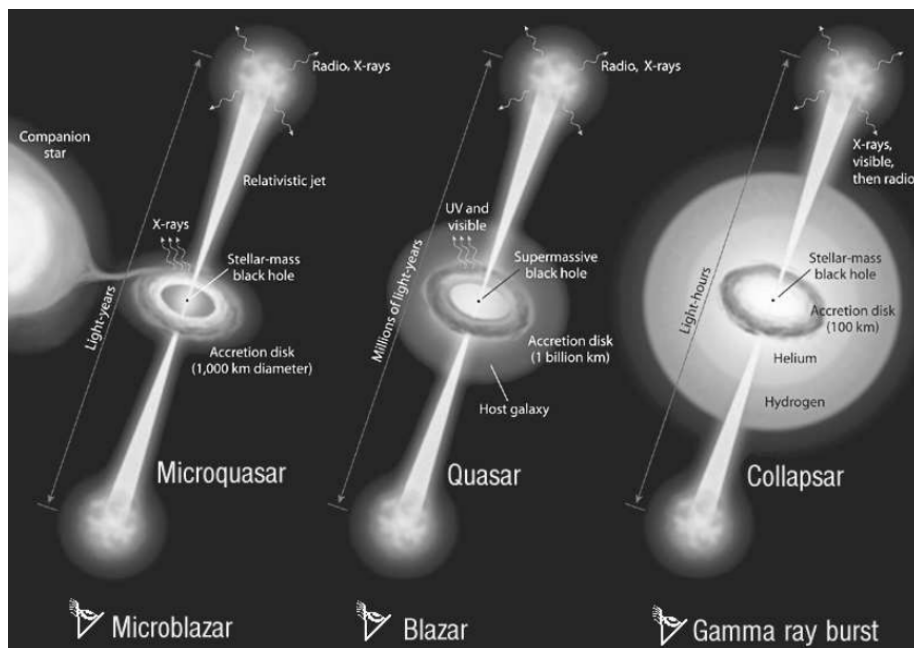


Figure 1.1: NOT in scale diagram, showing current ideas of micro-quasars, AGNs and gamma-ray bursts as space objects driven by same, universal mechanism Mirabel (2002).

- **Galactic ridge X-ray emission (GRXE):** various physical processes contribute to brightness of GRXE in different bands, but several studies in 3-20 keV provide evidence that diffuse X-ray radiation originates from a huge number of stellar X-ray sources, mostly coronally active stars and white dwarf X-ray binaries. In particular for the energies over 20 keV to 200 keV

is spectrum very similar to spectrum of magnetic white dwarf binaries – e.g. Intermediate polars (IP) and polars (P). Krivonos et al. (2007)

- **White dwarfs masses in IP:** Suleimanov et al. (2005)

1.2 Observations

Cataclysmic variable stars

2.1 Non magnetic cataclysmic variables

2.2 Magnetic cataclysmic variables

2.2.1 Polars

2.2.2 Intermediate polars

2.3 Galactic population of cataclysmic variables

2.4 Others important creatures

2.5 GXRE

Model of post shock region

- 3.1 Thermal bremsstrahlung**
- 3.2 Post shock region**
- 3.3 WD mass estimations methods**

Data analysis

Bibliography

- Adams, D. 1979, *The Hitchhiker's Guide to the Galaxy* (Great publishing house of Ursa Minor Beta)
- Aizu, K. 1973, *Progress of Theoretical Physics*, 49, 1184
- Brunschweiler, J., Greiner, J., Ajello, M., & Osborne, J. 2009, *A&A*, 496, 121
- Frank, J., King, A., & Raine, D. 2002, *Accretion Power in Astrophysics Third Edition* (University Press, Cambridge)
- Krivosos, R., Revnivitsev, M., Churazov, E., Sazonov, S., Grebenev, S., & Sunyaev, R. 2007, *A&A*, 463, 957
- Mirabel, I. F. 2002, *ASP Conference Series*
- Revnivitsev, M., Sazonov, S., Krivosos, R., Ritter, H., & Sunyaev, R. 2008, *A&A*, 489, 1121
- Rybicki, G. B. & Lightman, A. P. 1979, *Radiative Processes in Astrophysics* (John Wiley & Sons, Inc.)
- Sazonov, S., Revnivitsev, M., Gilfanov, M., Churazov, E., & Sunyaev, R. 2006, *A&A*, 450, 117
- Suleimanov, V., Revnivitsev, M., & Ritter, H. 2005, *A&A*, 435, 191
- Warner, B. 1995, *Cataclysmic Variable Stars* (University Press, Cambridge)
- Yuasa, T., Nakazawa, K., Makishima, K., Saitou, K., Ishida, M., Ebisawa, K., Mori, H., & Yamada, S. 2010, *A&A*, 520, A25+

Appendix

this will be the appendix

Table 1: Estimated WD masses from previous reports ...

System	Suzaku XIS+HXD M_{WD}	Swift BAT M_{WD}	RXTE PCA+HEXTE M_{WD}	RXTE PCA M_{WD}	Ginga LAC M_{WD}	ASCA SIS M_{WD}	This work XMM & Integral M_{WD}
FO Aqr							
XY Ari							
MU Cam							
BG CMi							
V709 Cas							
TV Col							
TX Col							
YY Dra							
PQ Gem							
EX Hya							
NY Lup							
V2400 Oph							
AO Psc							
V1223 Sgr							
RX J2133							
IGR J17303							