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Determining the role of irradiation in radiation pressure instabilities

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Main engine of X-ray binaries is an accretion disk:

Most successful model: optically thick-geometrically thin geometry

Very well studied, and proven by several observations

Yet, this solution is unstable at luminosities >10% Eddington



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When Pradiation > Pgas, the disk becomes thermally and viscously unstable (red region)

A stable branch is found above Eddington (slim accretion disk)





From observations point of view, scenario is not clear

Only the the BH GRS 1915 is known for showing instabilities





Janiuk+2001

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Janiuk+2001, Fragile+2018

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Few sources show similar episodes....unclear if it is same process



Swift J1858 Campaign:

Simultaneous high-time resolution observation with 5 bands

Remarkable flares across EM spectrum!



Vincentelli+2023

IR lightcurve from a NS = X-ray lightcurve from a BH (!?!?!)



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The Swift J1858 instabilities: Implications

Swift J1858 is a low luminosity Z-source!



Migliari & Fender 2006, Muñoz Dairas+2014, Motta & Fender 2019

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Thus the flaring branch is a result of the instability!

A new quest begins!

Ideal target to shed light on nature of instability and differences between BH ad NS

What regulates the heartbeat duration?



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Main difference between BHs and NSs is the presence of hard surface

this lead to additional irradiation term!

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Minshige & Kusunose 1993

First step using Dubus+1999 prescription:

 $T_{\rm irr}^4 = C \frac{\dot{M}c^2}{4\pi\sigma R^2},$

with $C \equiv \eta (1 - \varepsilon) \frac{H_{\rm irr}}{R} \left(\frac{\mathrm{d} \ln H_{\rm irr}}{\mathrm{d} \ln R} - 1 \right),$

Preliminary modelling confirms that irradiation significantly affect the heartbeats

Potentially very constraining on geometry

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Conclusions:

- We showed that instabilites can have different appearance than X-ray oscillations
- This opens the possibility to extract new physical parameters from high mdot sources
- It enables to give a new physical interpretation to Z-sources phenomenology
- Preliminary inclusion of irradiation in GLADIS shows that the burst profile is changing

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