

# Accretion and ejection from black holes

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# Introduction

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- ❑ Since this is a workshop, and in order to stir up discussion, I would like to be a little **provocative**.
- ❑ Our community has some **fixed ideas** (I would call them **party lines**) and it is considered a “sin” to question them.
- ❑ At my age, and career stage (retired), I can go against the party line with no penalty.
- ❑ Hopefully, I have something interesting to say.

# Two rhetoric questions

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- What creates the strong poloidal magnetic field that is needed for the ejection of a jet in AGN, BHXRBS, and NSs?
- Is the Blandford-Znajek (1977) mechanism the correct mechanism for jet ejection?

# Answer to the first question according to the party line

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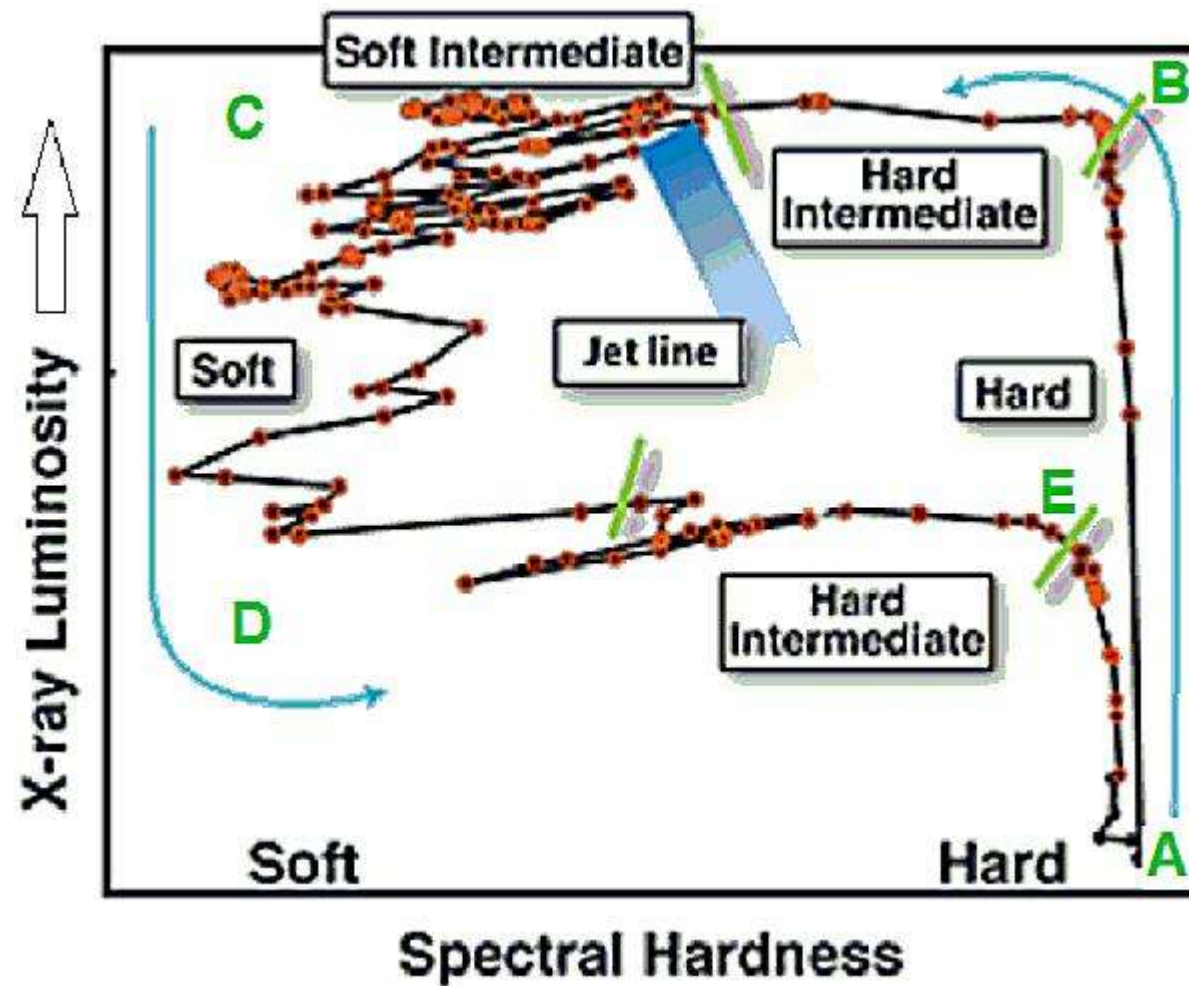
- ❑ It is widely accepted that a weak magnetic field from far away is advected towards the black hole and, during this advection, it gets amplified by random processes, such as turbulence.
- ❑ This process creates poloidal magnetic fields strong enough to eject a jet.
- ❑ GRMHD simulations have shown this to be correct.

# AGN vs. BHTs

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- ❑ In AGN, the timescale for significant changes in a source is millions of years, which is  $\gg$  human lifetime.
- ❑ On the other hand, this timescale in BHTs is of the order of months!!!
- ❑ Due to the similarity of AGN with BHTs (fundamental plane), it is worth examining BHTs and transferring conclusions from BHTs to AGN.
- ❑ Let's look at GX 339-4, the best studied BHT.

# GX 339-4



# Criss-crossing of the jet line

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- ❑ In BHTs, sources are observed to criss-cross the jet line **within hours!!!**
- ❑ In other words, **a compact jet is created within hours, when a source crosses the jet line** from left to right.
- ❑ Thus, the source must **anticipate** that it will need a strong poloidal magnetic field in a few hours, to order a magnetic field from far away, which should be amplified on the way and **arrive at the right place at the right time!!!**

# Criss-crossing of the jet line

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- ❑ In my opinion, the mechanism for creating the strong poloidal magnetic field to eject a jet **must be local**.
- ❑ I will come back to this after I discuss the second question.



# Answer to the second question according to the party line

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- It is widely accepted that the Blandford-Znajek mechanism is responsible for the ejection of jets in AGN and BHTs.
- I have no problem with this. In fact, I like it a lot.

# However,

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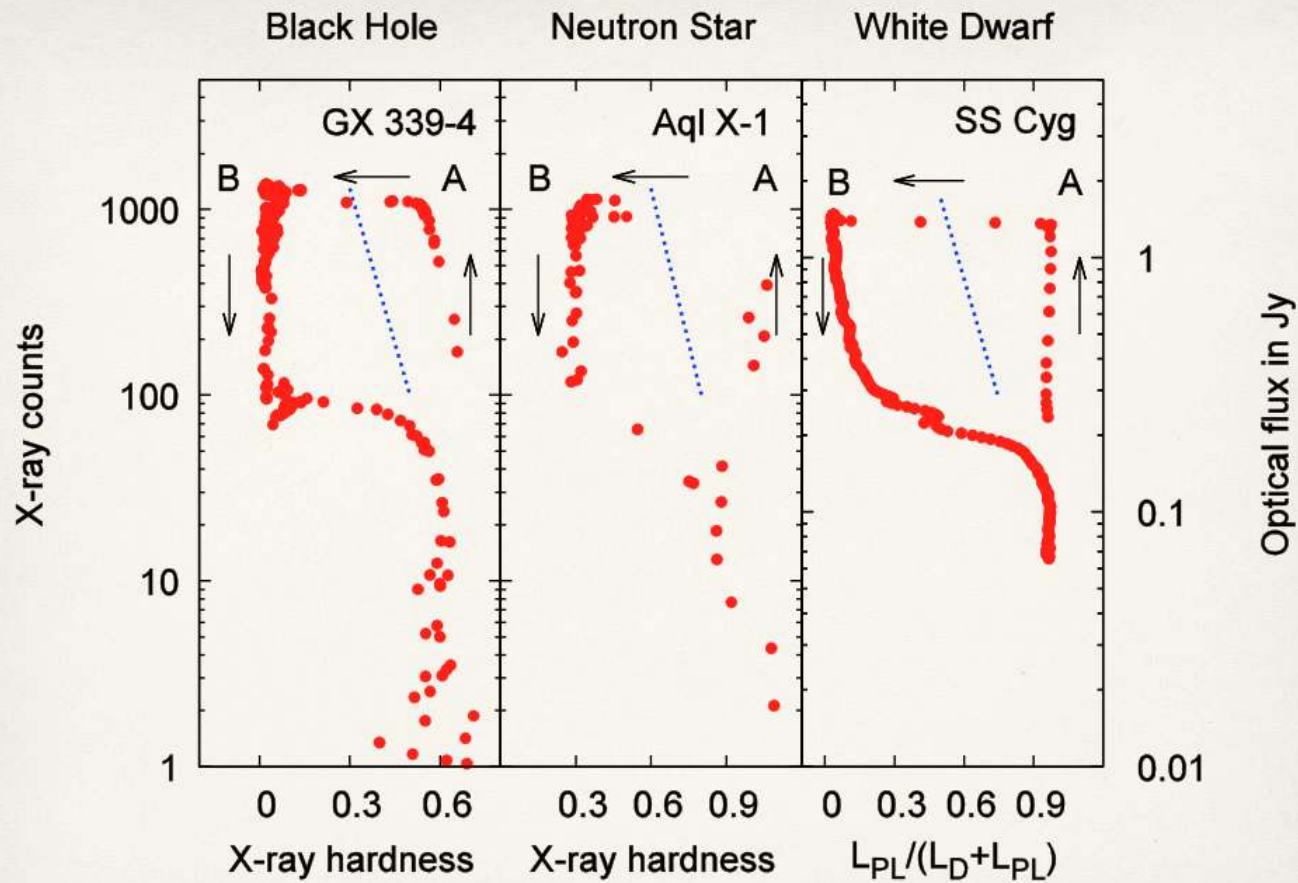
- as I was preparing this presentation, I came across the preprint of Giovannini et al. (2018), which claims that now we have **observational evidence** that the jet in 3C 84 (NGC 1275) is **much wider** than the Blandford-Znajek mechanism predicts for jet launching by the ergosphere.
- The authors conclude that **the jet is launched by the accretion flow** (Blandford & Payne 1982 mechanism).

# BHs vs. NSs

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- ❑ NSs are also seen to emit jets.
- ❑ NS jets have many similarities with BH ones, and some differences, because NSs have a solid surface.
- ❑ One cannot invoke the Blandford – Znajek mechanism to explain jets from NSs.
- ❑ What is more impressive is

# Similar behavior for BH, NS, WD!!!



The jet line in the Hardness-Intensity Diagram (Kording *et al.* 2008)

# Remark

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- ❑ I cannot exclude the possibility that there are more than one mechanism for the ejection of jets from compact objects.
- ❑ However, if we are to explain all jets from compact objects by one mechanism, we must turn to the Blandford – Payne (1982) mechanism, which ejects jets from the accretion flow.
- ❑ For the rest of my talk, I will assume the Blandford-Payne mechanism.

# Cosmic Battery (CB)

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- A beautiful idea was proposed by Contopoulos & Kazanas (1998), but our community has not paid yet the attention that it deserves. **It will though!!!!**
- The CB is a **local** mechanism for creating poloidal magnetic field for the ejection of a jet, **where it is needed and when it is needed.**
- Let me explain the idea of the CB.

# Cosmic Battery (2)

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- The CB works efficiently when there is a geometrically thick, optically thin, hot inner flow.
- That's why there is **always** a jet when the spectrum is hard.
- It was shown (Kylafis et al. 2012) that, near Eddington luminosity, the CB creates the required poloidal magnetic field for ejection of a jet **in an hour!!!**
- No need to call for a magnetic field from far away.

# Cosmic Battery (3)

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- ❑ The CB **does not care what the central object is!**
- ❑ All it requires is a hot inner accretion flow (hard state).
- ❑ It was demonstrated by Contopoulos et al. (2018) that the CB, having a definite polarity, **dominates over all random processes.**
- ❑ **The CB creates strong poloidal magnetic field, whether you like it or not. 😊**

THANKS