

# Formation and destruction of jets in X-ray binaries

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# Introduction

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- ❑ Jets have been seen from binaries containing all three kinds of compact objects: Black holes, neutron stars, and white dwarfs.
- ❑ Contrary to intuition (but easily explainable!), black-hole X-ray binaries exhibit the strongest jets.
- ❑ Thus, I will concentrate here on black-hole X-ray binaries.

# Schematic representation of a compact X-ray binary with a jet.

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# Formation of a jet from an accretion disk

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- ❑ Especially for black holes, the ejection of a jet is counter intuitive. Our intuition says that all the matter in the accretion disk should go into the black hole.
- ❑ Let's examine a mechanical analog.

# Ejection of a jet

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- ❑ The role of the wires in an accretion disk is played by the magnetic-field lines.
- ❑ Electrons and ions can move freely along the magnetic field.
- ❑ Thus, the centrifugal force and the magnetic field can create a jet (Blandford and Payne 1982).

# Formation of the magnetic field

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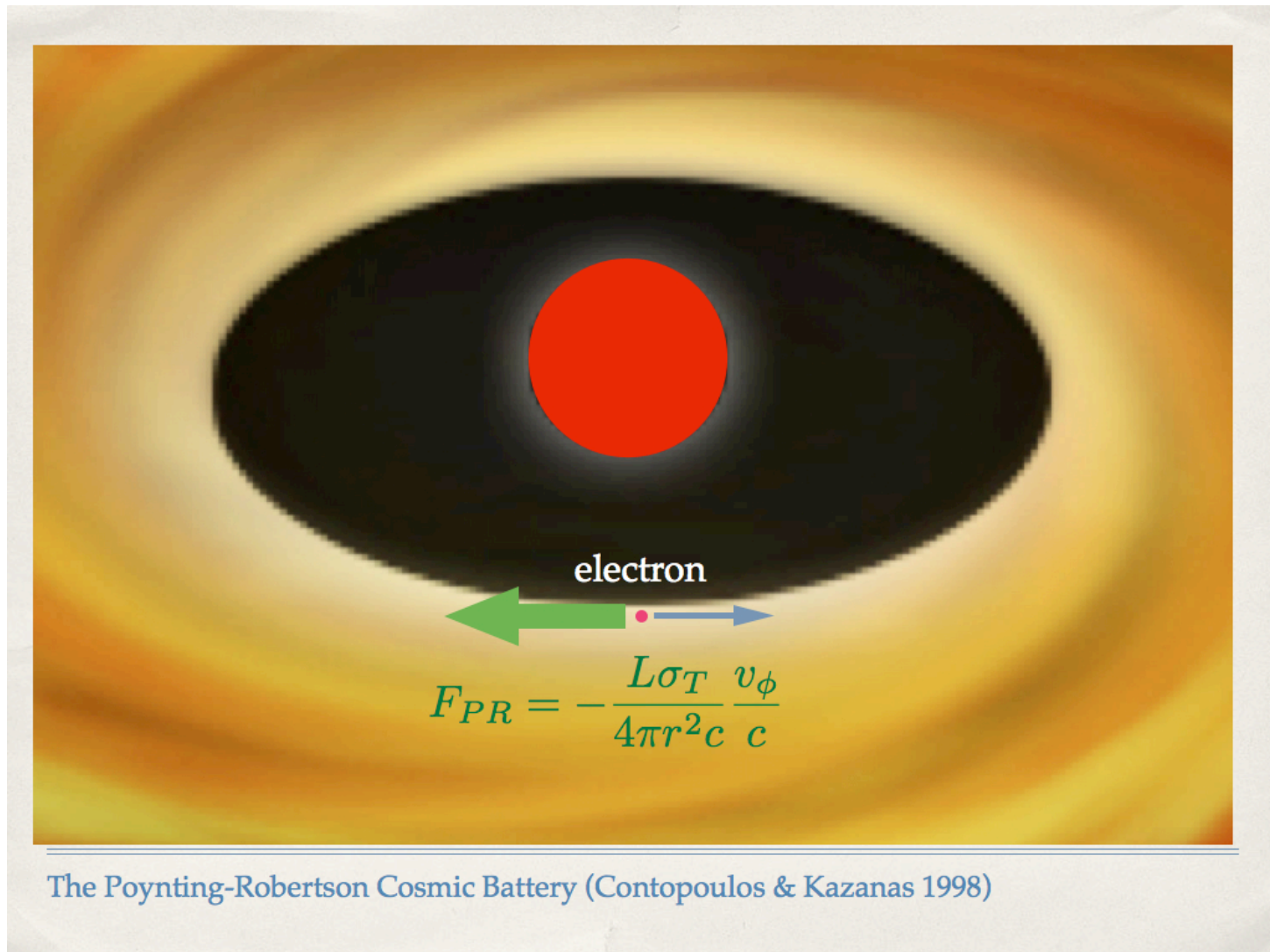
- ❑ In order to have a magnetic field coming out of the disk, we must have a current in the direction of rotation of the disk.
- ❑ In order to have a current, we must have a mechanism that creates or amplifies a magnetic field.
- ❑ Human thought versus Mother Nature.

# Cosmic Battery (Contopoulos & Kazanas 1998)

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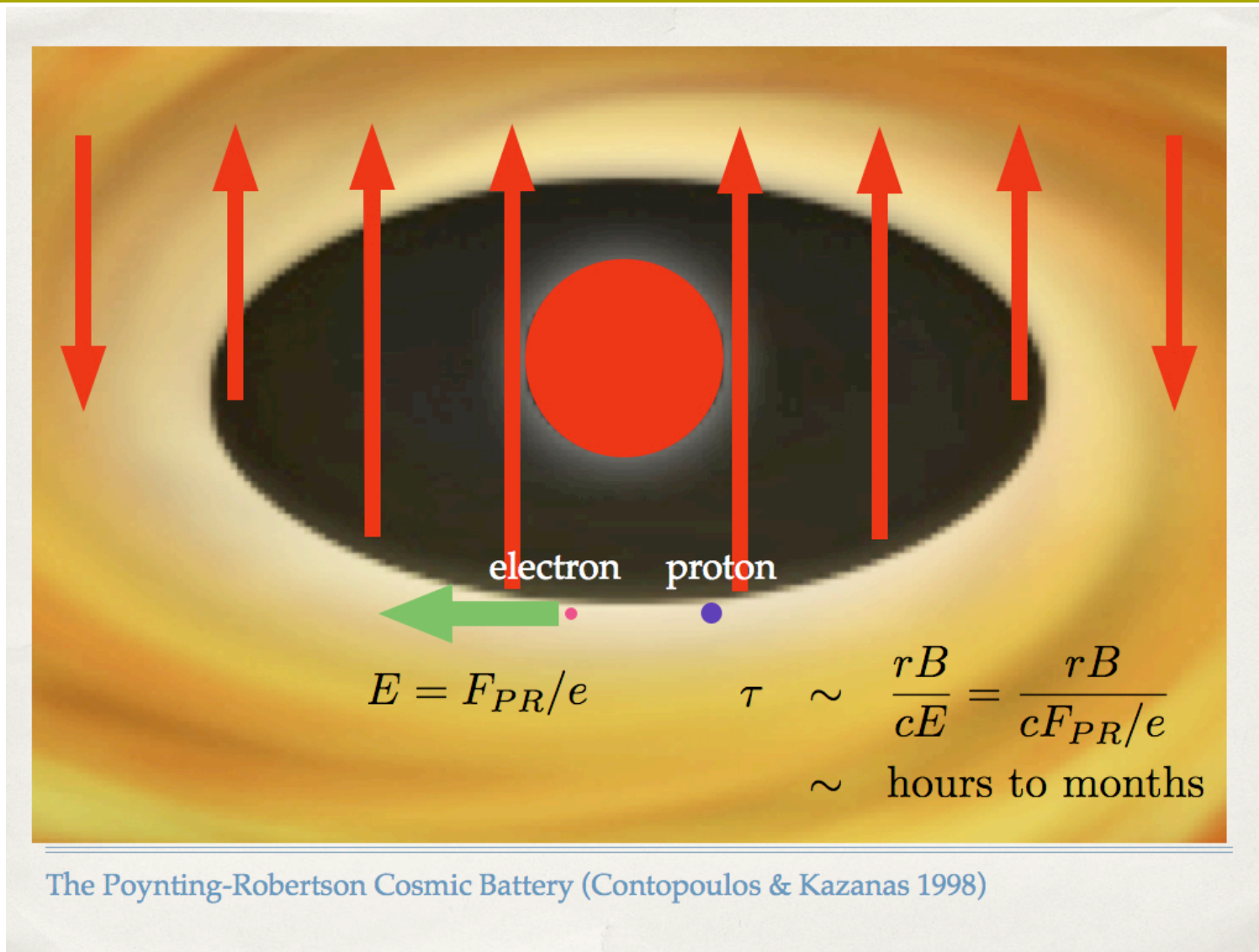
- ▣ A truly ingenious idea was proposed by I. Contopoulos & D. Kazanas in 1998.
- ▣ The radiation from the inner part of the accretion disk hits the opposite side of the disk and exerts a force (Poynting–Robertson - type) on the electrons. The electrons slip with respect to the ions and thus a current is created in the direction of rotation of the disk.

# Poynting-Robertson Cosmic Battery





# Poynting - Robertson Cosmic Battery

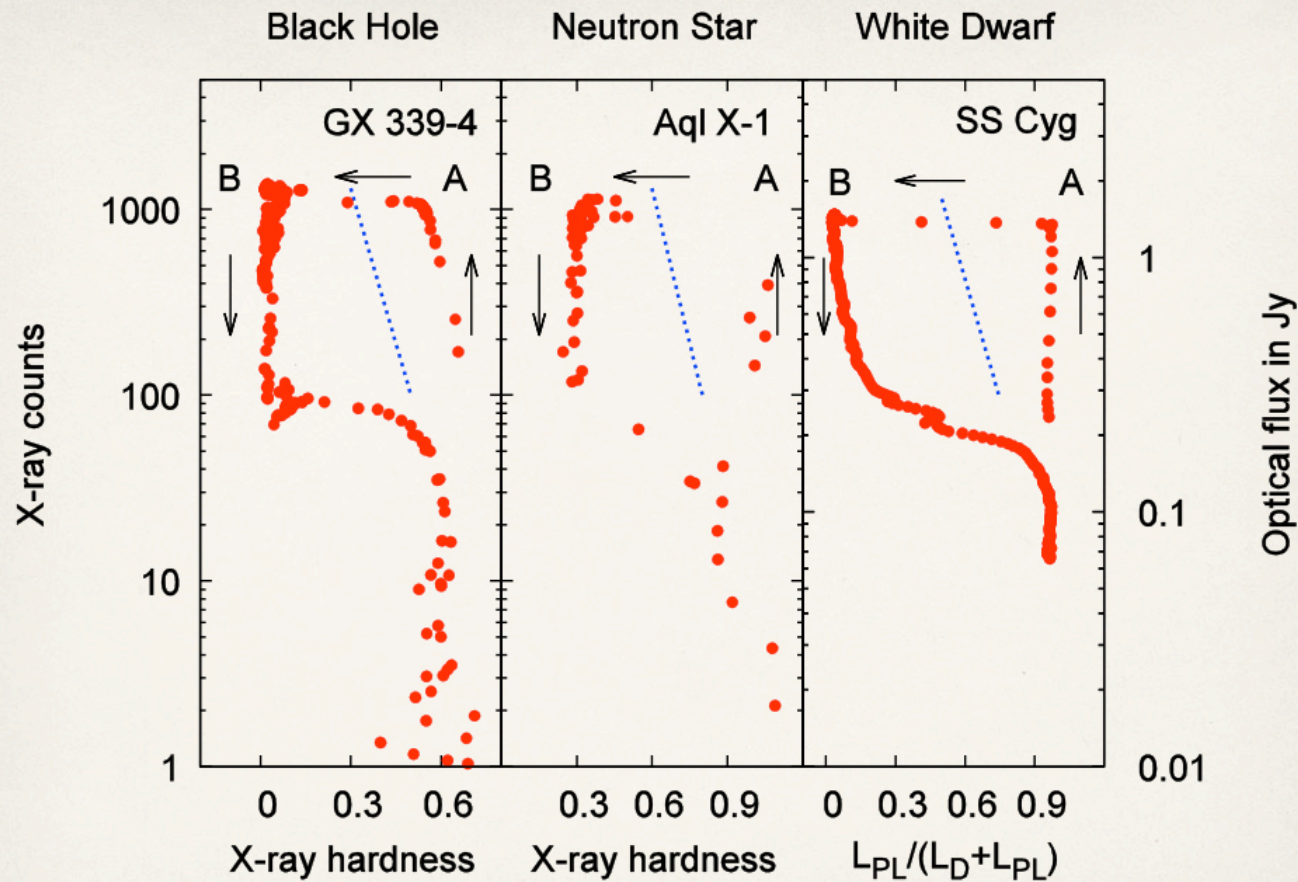


# Phenomenology of binary X-ray sources

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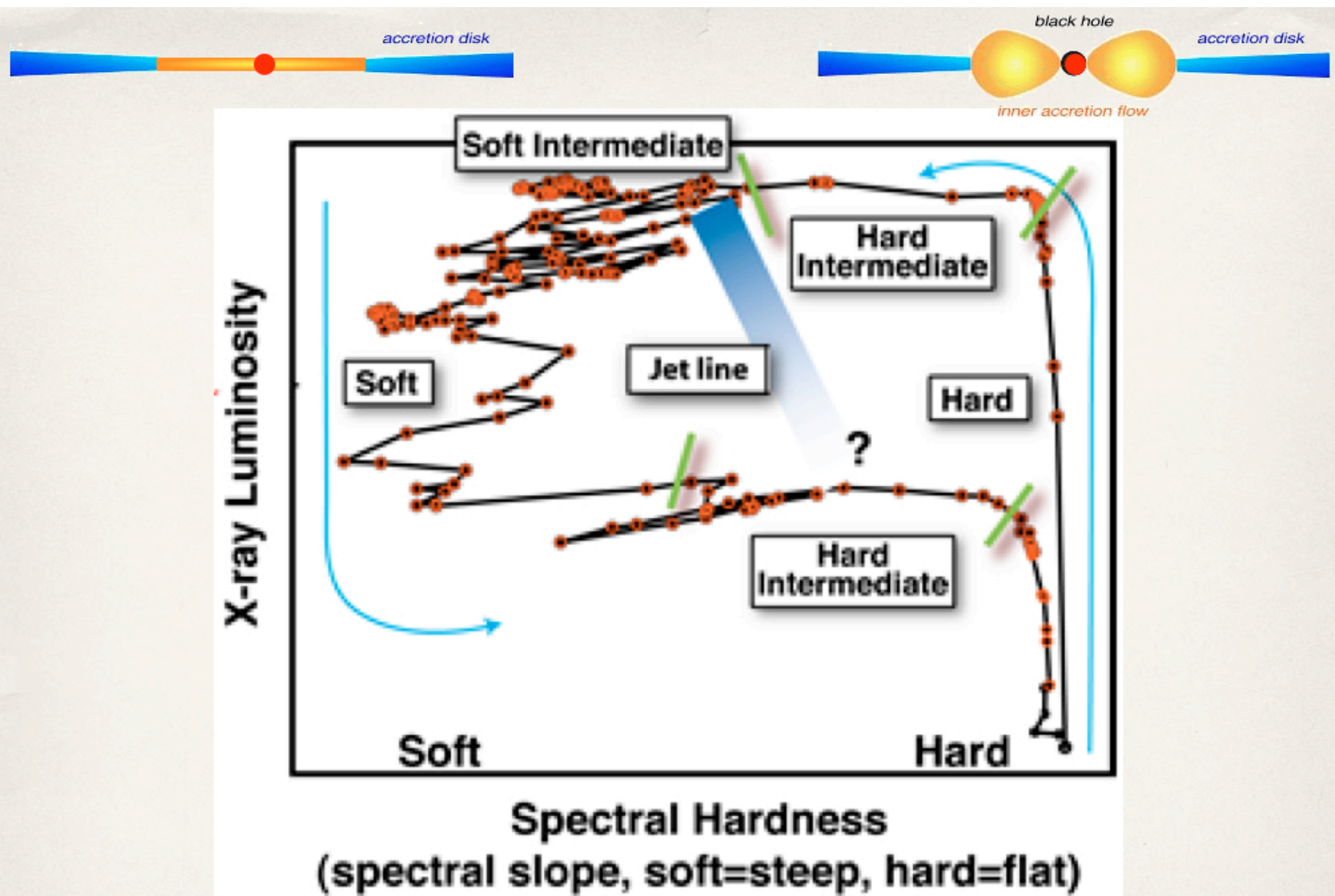
- ▣ There is a lot of phenomenology regarding binary X-ray sources.
- ▣ In this work, we will show that all this phenomenology makes sense in the context of the Cosmic Battery.

# The Cosmic Battery works for BH, NS, WD.



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

# GX 339-4



The jet line in the HID (Kylafis, Contopoulos, Kazanas & Christodoulou 2011, submitted)



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Thank you for your attention.