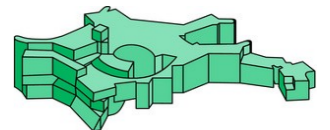


Luminosity dependent change of the emission diagram in the X-ray pulsar 4U 1626-67

F. Koliopanos & M. Gilfanov 2015, MNRAS

Speaker:

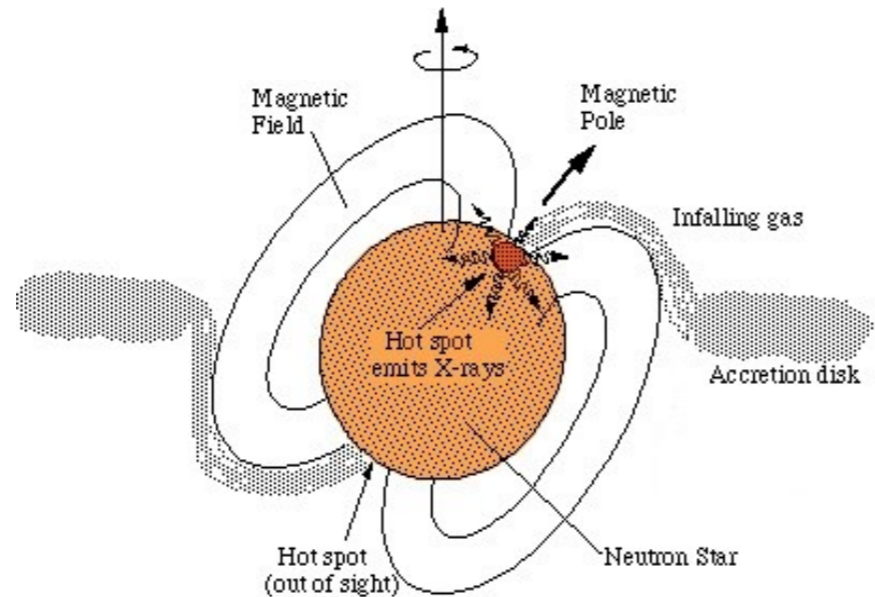
Filippos Koliopanos



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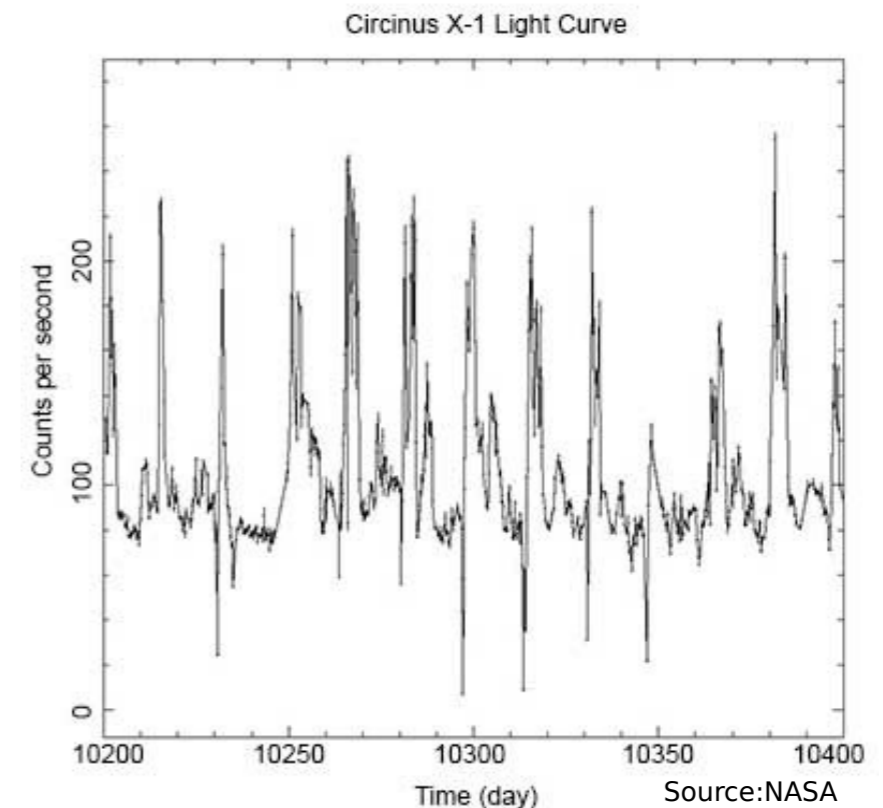
X-ray Pulsars



Source:NASA

- High **field** neutron stars in **binary** systems
- **Material** from companion is **transferred** onto the NS
- Accretion disk is **disrupted** by strong magnetic field.

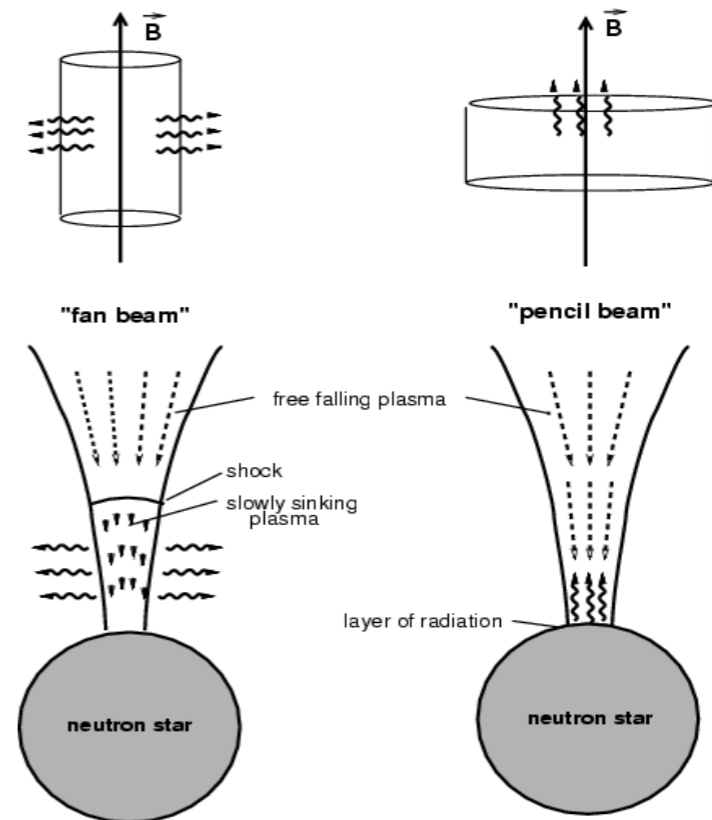
- Material is **channeled** towards the **poles** of the NS
- Anisotropic **emission**, NS with **spin** results in **pulsed** emission.
- Accretion disk is **disrupted** by strong magnetic field.



X-ray Pulsar Emission

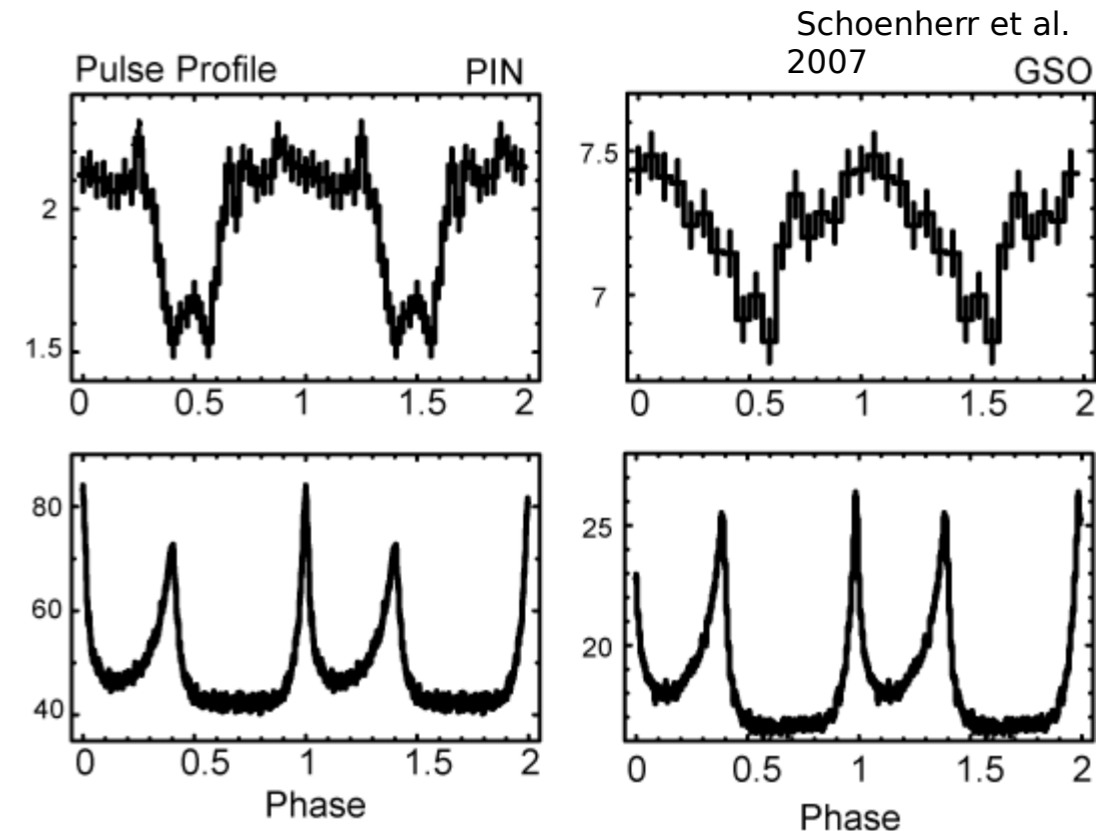
- **Fan or Pencil Beam emission**

- The assumption of an **isotropically** emitting polar cap is rather simplistic. The **pulsar emission** is most likely **beamed**.
(*Basko & Sunyaev 1975, 1976*)
- For luminosities exceeding $\sim 10^{37}$ erg/sec the emission diagram of the accretion column may switch from a **pencil-beam** to a **fan-beam** pattern.
(*Basko & Sunyaev 1976; Wang & Frank 1981*)



- **Shape of the pulse profile**

- **Pencil**-beamed emission is often associated with **sinusoidal-like** pulse profiles*.
(*e.g. Meszaros 1992*)
- **Double peaked** profiles are indicative of emission that is **fan-beam** dominated.
(*e.g. Nagel 1981; White, Swank & Holt 1983; Paul et al. 1996, 1997; Rea et al. 2004*)



4U 1626-67

- **4U 1626-67 - A Unique X-ray Pulsar:**

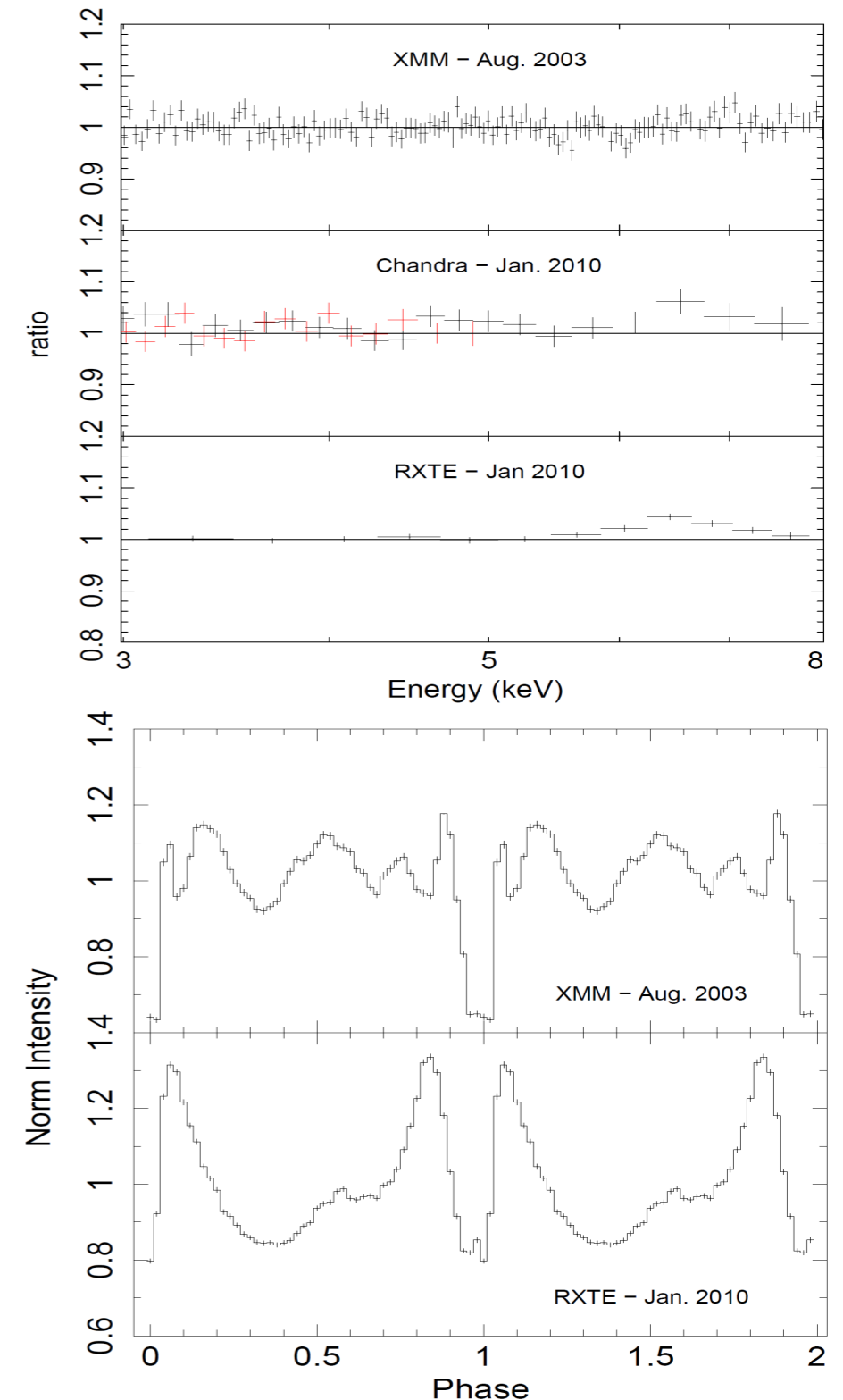
- It is the only known ultracompact, high-field pulsar discovered so far. With a **magnetic field of $\sim 3 \times 10^{12}$ Gauss.**
- Has a **pulse** period of **7.7s** and an **orbital** period of **~ 42 min.**

- **Low and high luminosity phases.**

- Between **1977** and **1990** the source luminosity was estimated at **$\sim 10^{37}$ erg/sec** and its pulse profile displayed a characteristic double peaked shape.
(White, Swank & Holt 1983; Beri et al. 2014)
- After **1990** and until **2008** the source entered a period of **decreased flux** and its pulse profile changed to a **broader shape** that did not display the previously observed peaks
(Krauss et al. 2007)
- Since **2008** the source has re-entered a **high luminosity phase** with its pulse profile returning to the **double peaked** shape.
(Jain, Paul & Dutta 2010; Camero-Arranz et al. 2012; This work)

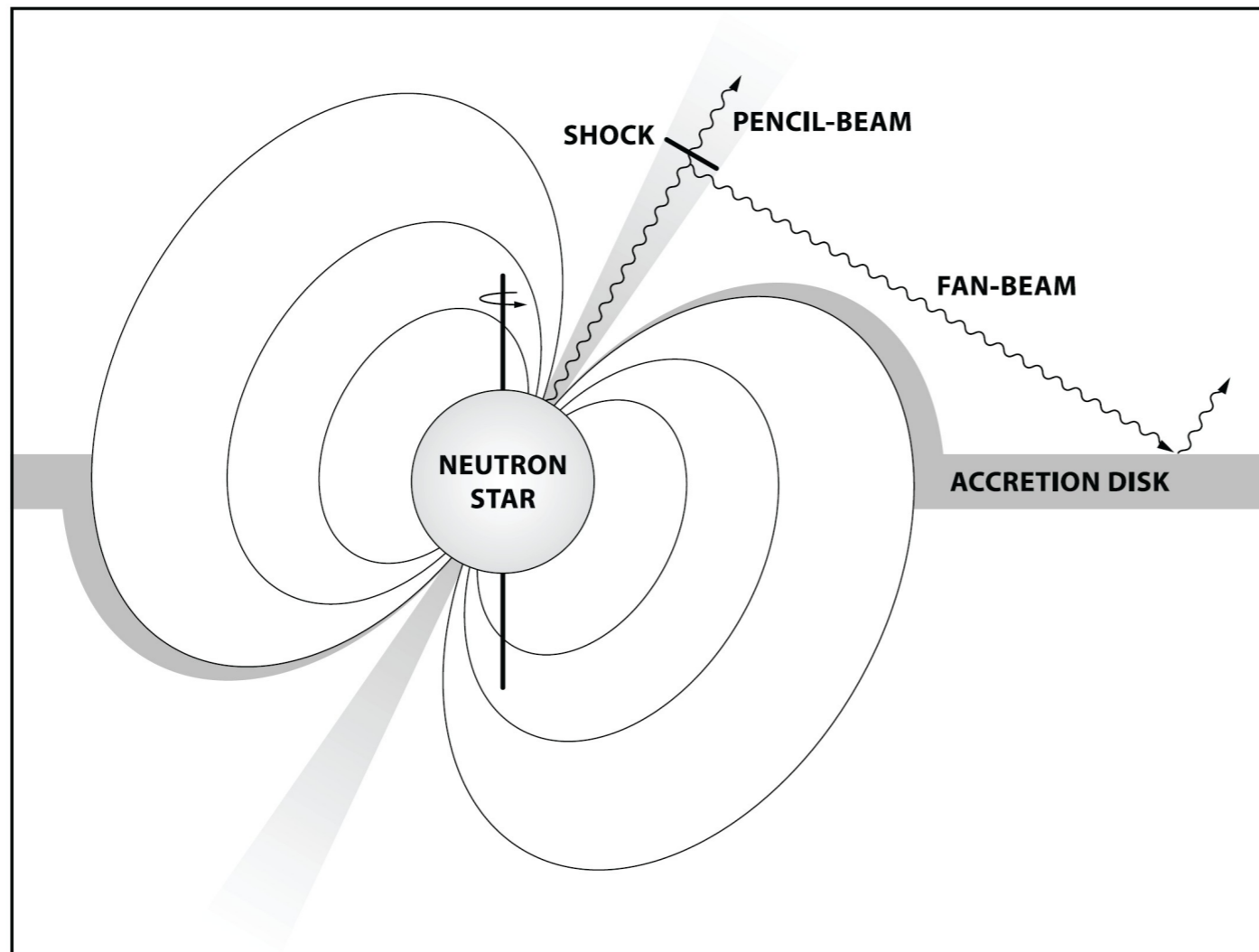
Evidence of emission diagram change in 4U 1626-67

- **2003 XMM-Newton observation – Low luminosity phase.**
 - No Iron line present with an **EW upper limit of ~ 2.4 eV** at 90% confidence.
 - **Broad pulse profile** with multiple small peaks.
- **2010 Chandra/RXTE observation – High luminosity phase.**
 - Presence of narrow Fe Ka line, centered at **~ 6.4 keV**, with an **equivalent width of ~ 18 eV**.
 - The iron line has a width of **~ 36 eV**, indicating origin in an accretion disk, truncated at **$R \sim 7.5 \times 10^8$ cm** from the NS.
 - We show that the small **EW** of the Fe Ka line is consistent with reflection off a disk with an **O/Fe** ratio that is **68** times the solar value. See also Koliopanos et al. 2013
 - The pulse profile has a characteristic **double-peaked** shape.

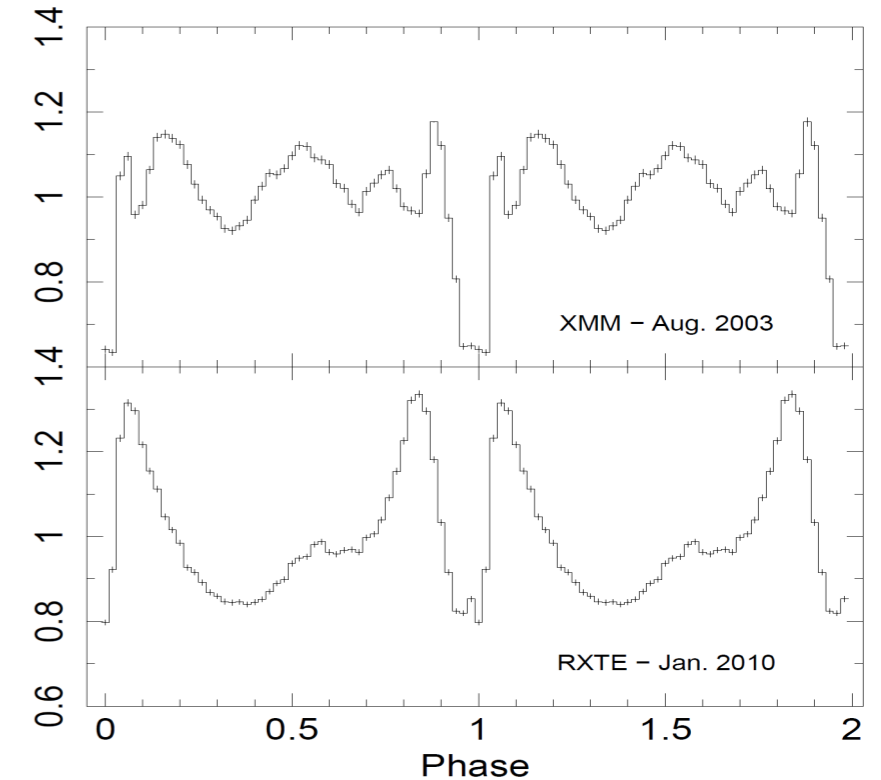
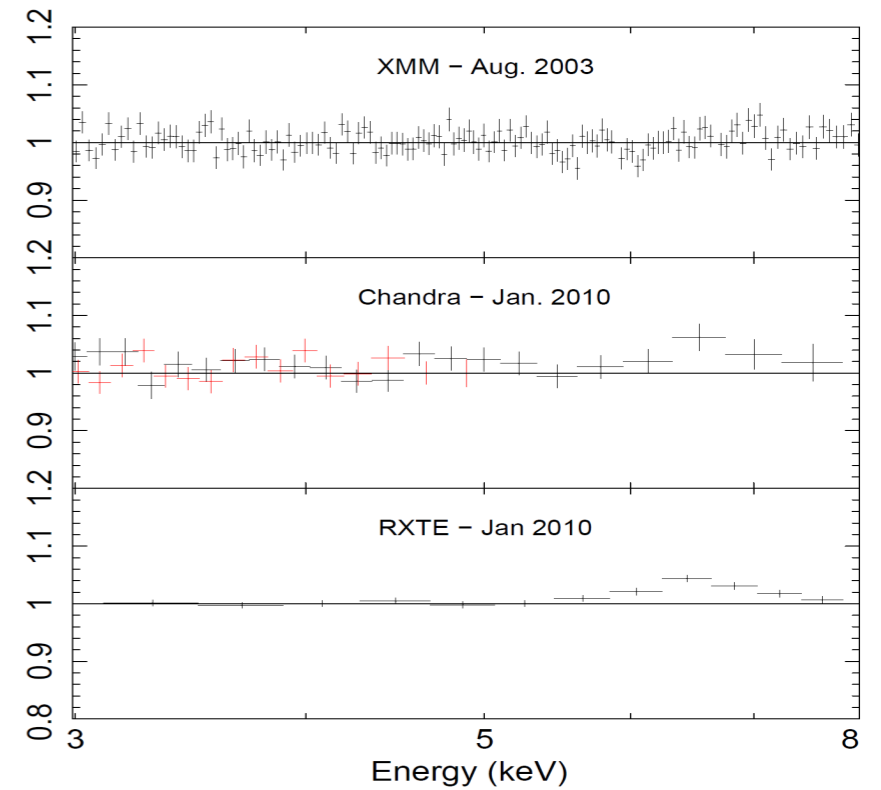


Evidence of emission diagram change in 4U 1626-67

- 2003 XMM-Newton observation – Low luminosity phase.

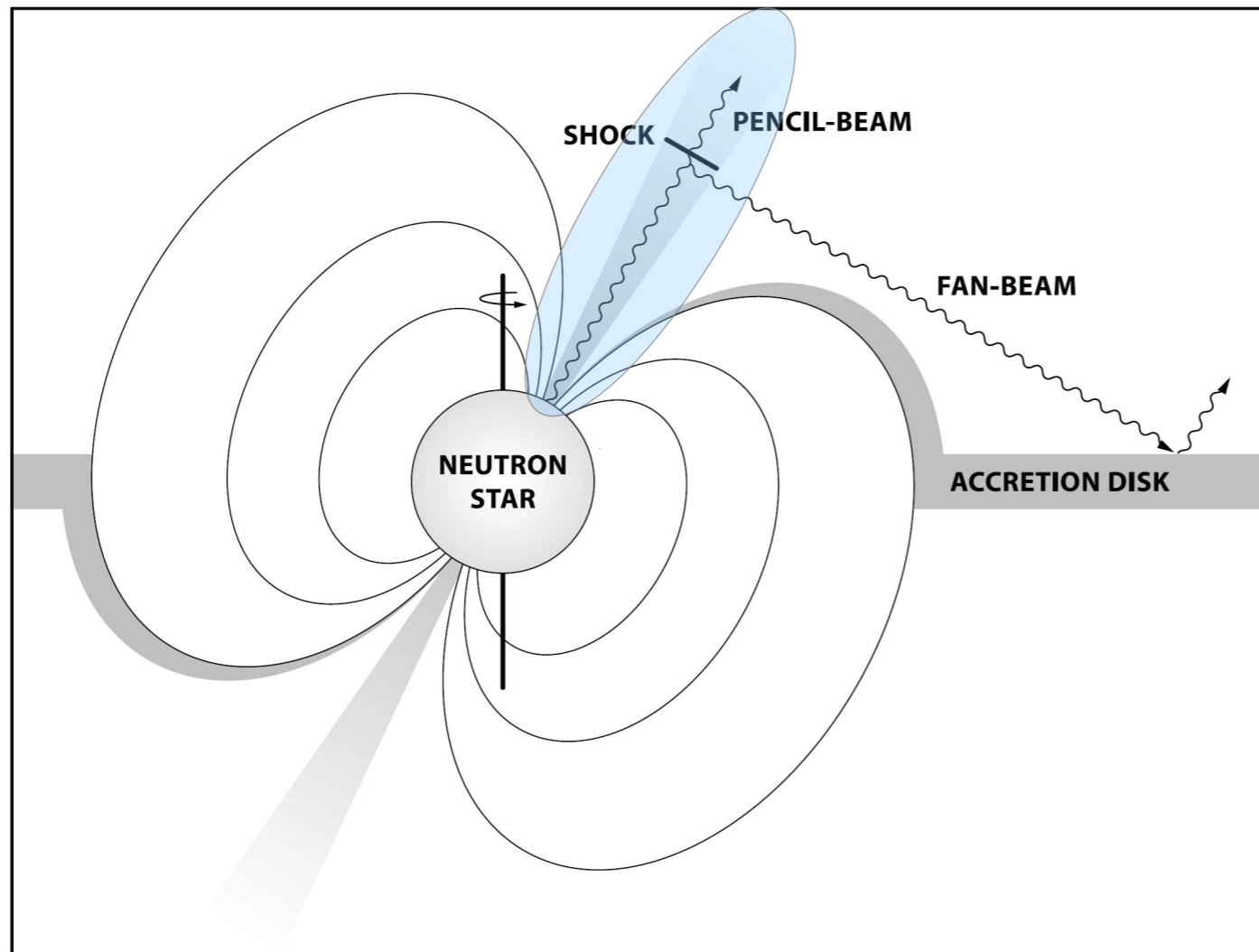


shape.

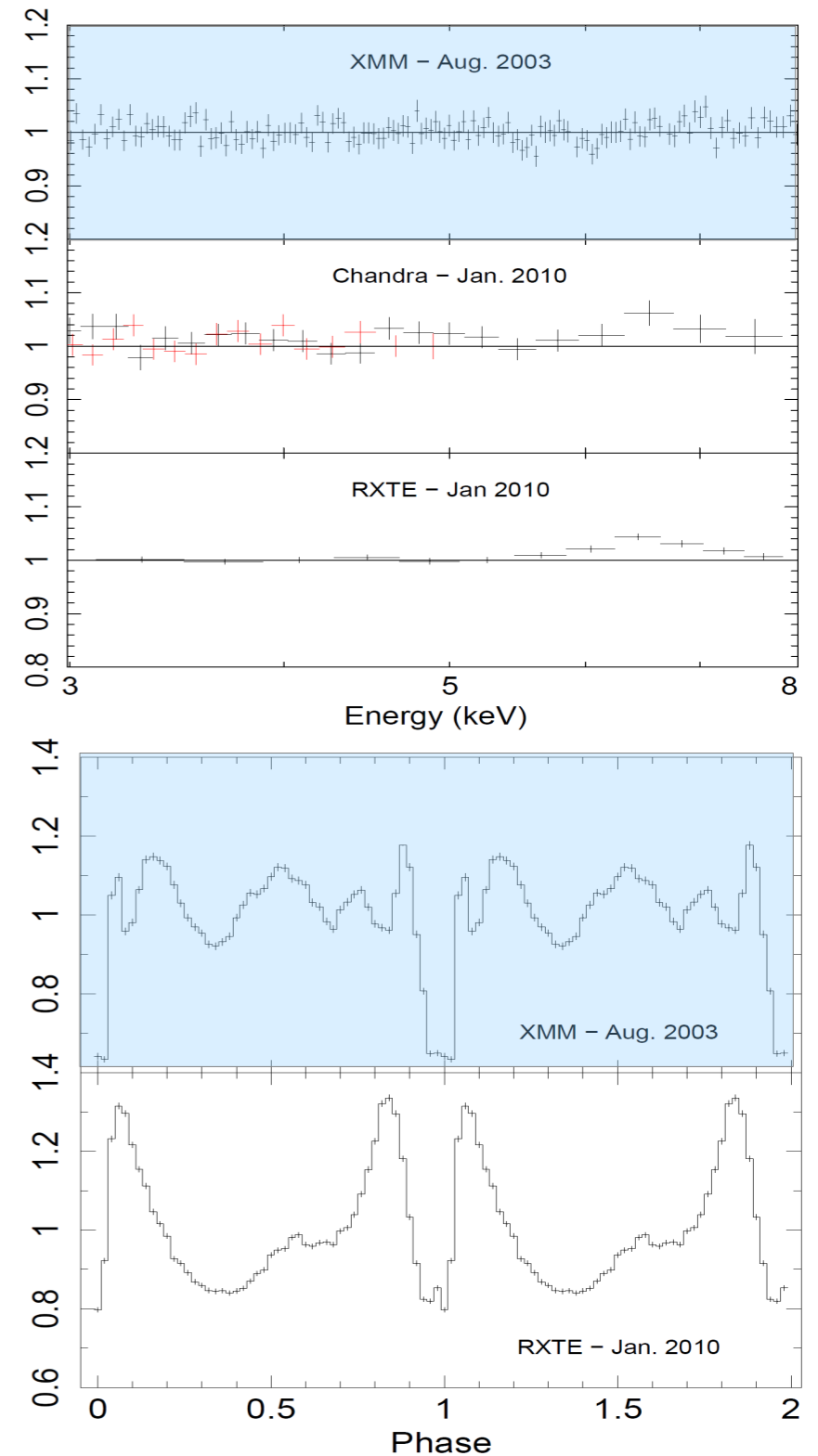


Evidence of emission diagram change in 4U 1626-67

- 2003 XMM-Newton observation – Low luminosity phase.

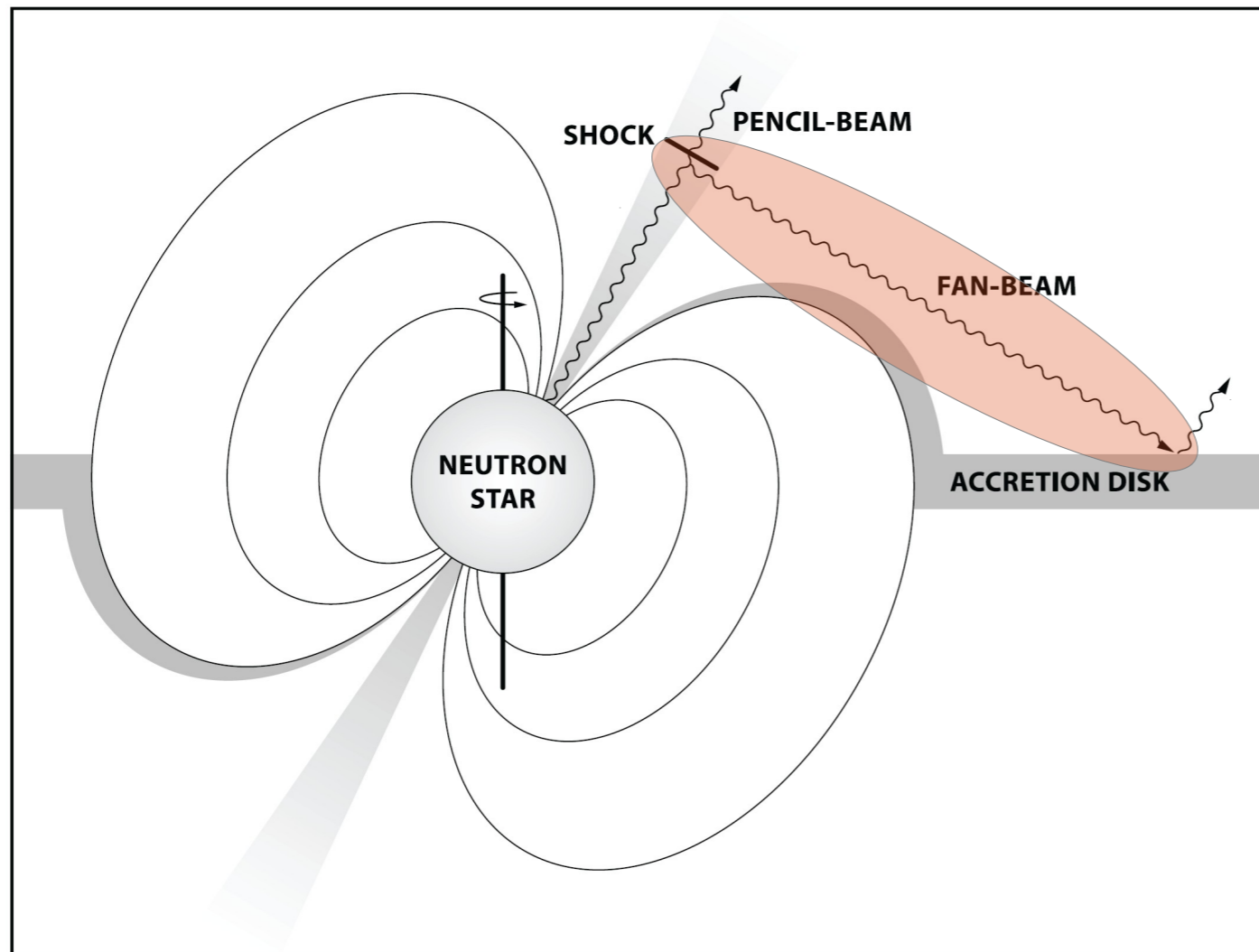


shape.

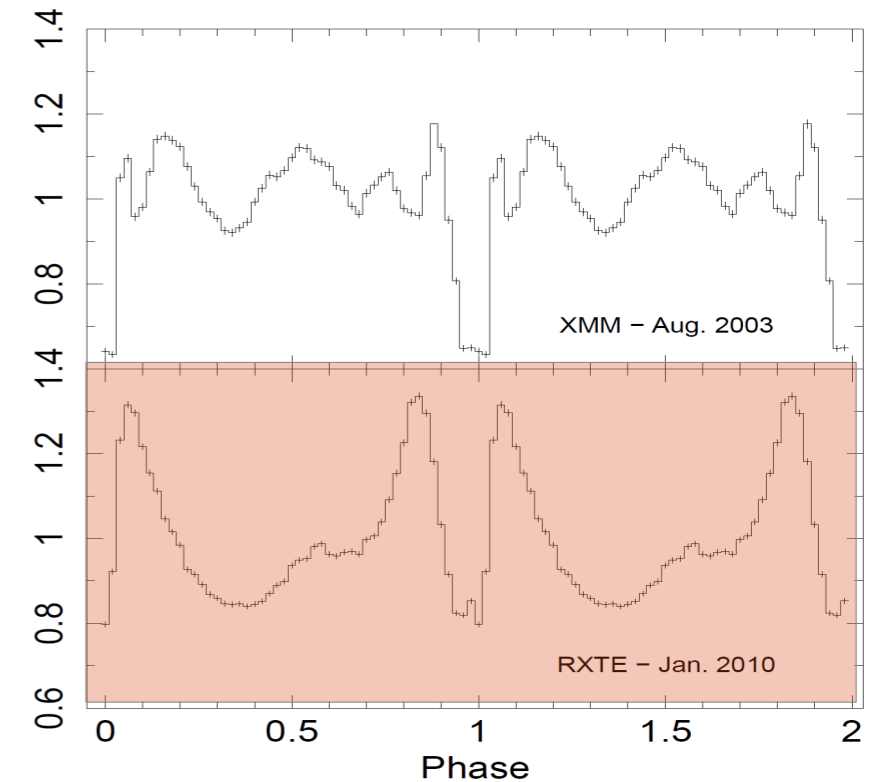
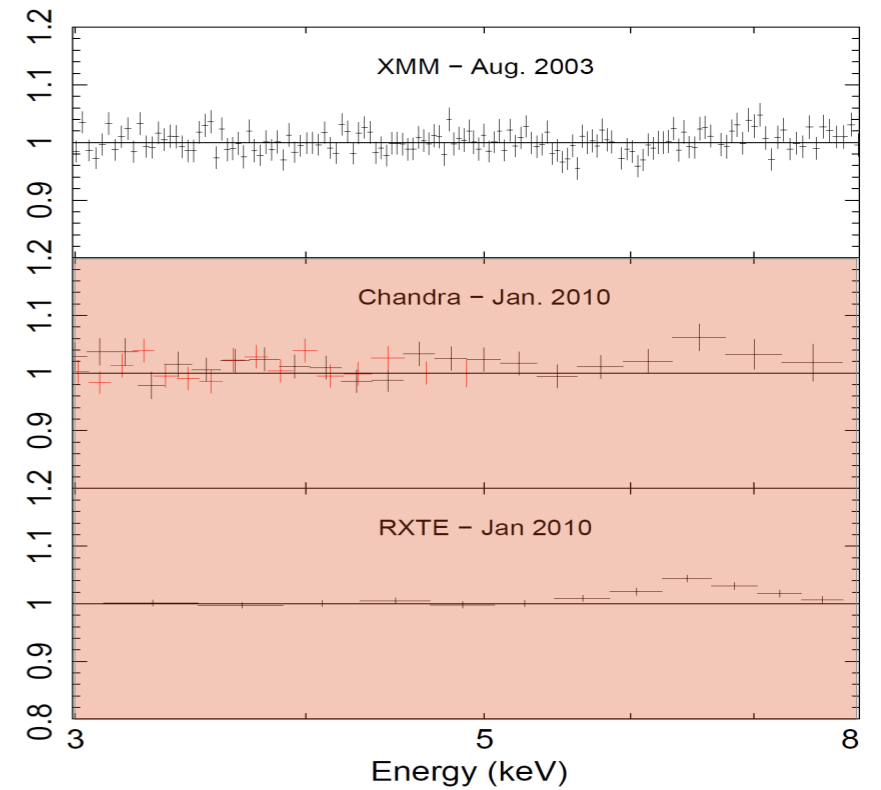


Evidence of emission diagram change in 4U 1626-67

- 2003 XMM-Newton observation – Low luminosity phase.

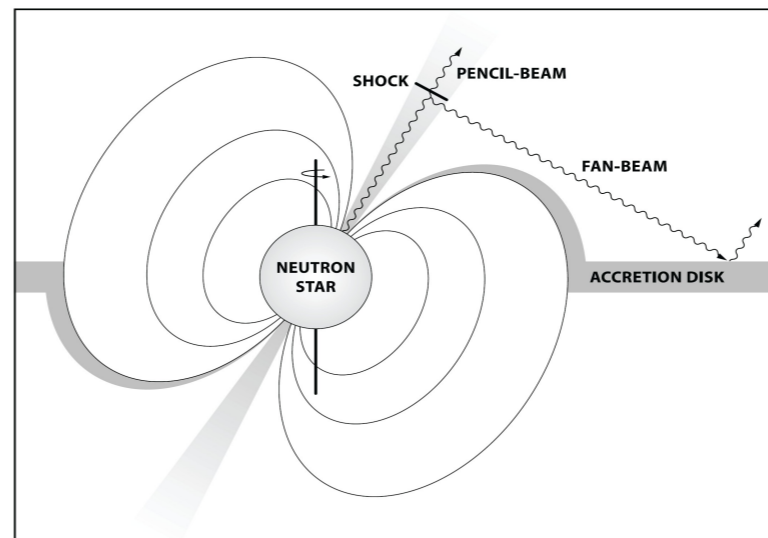


shape.



Summary and Conclusions

- We have discovered the **appearance** of a **narrow Fe K α** emission line in the spectrum of the X-ray pulsar **4U 1626-67**.
- The appearance is **correlated** with a major change in the shape of the **pulse profile** and an **increase** in the **luminosity** of the source



- We argue that both changes are caused by the same reason – a significant **modification** of the **emission diagram** of the accretion column, from a **pencil** beam to a **fan** beam pattern.
- These are the **first** spectroscopic **evidence** of a mechanism that was first put forward in 1976 by Basko & Sunyaev.