CARACTERIZAÇÃO DO SISTEMA IMAGEADOR DO EXPERIMENTO PROTOMIRAX E BUSCA POR ASSINATURAS PERIÓDICAS DO CANDIDATO A BURACO NEGRO 1E 1740.7-2942

... e mais algumas coisas

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Workshop da Divisão de Astrofísica

8 e 9 de Maio de 2018

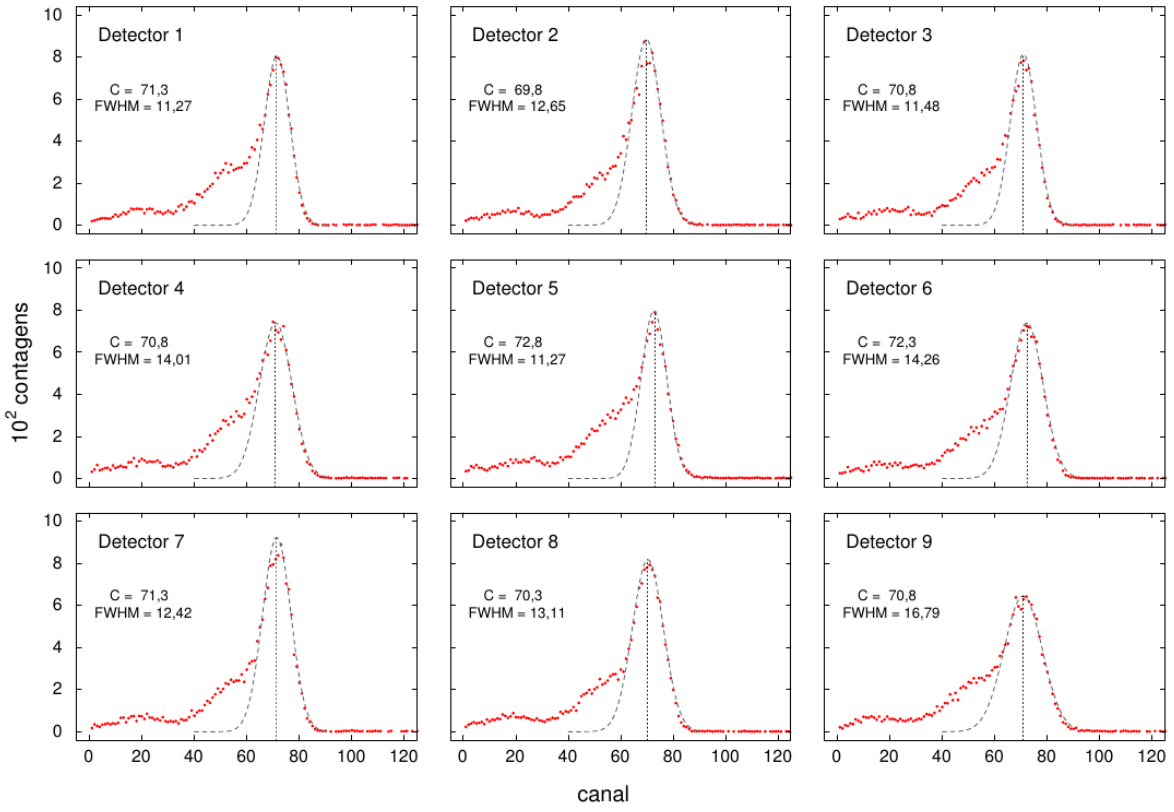
INPE

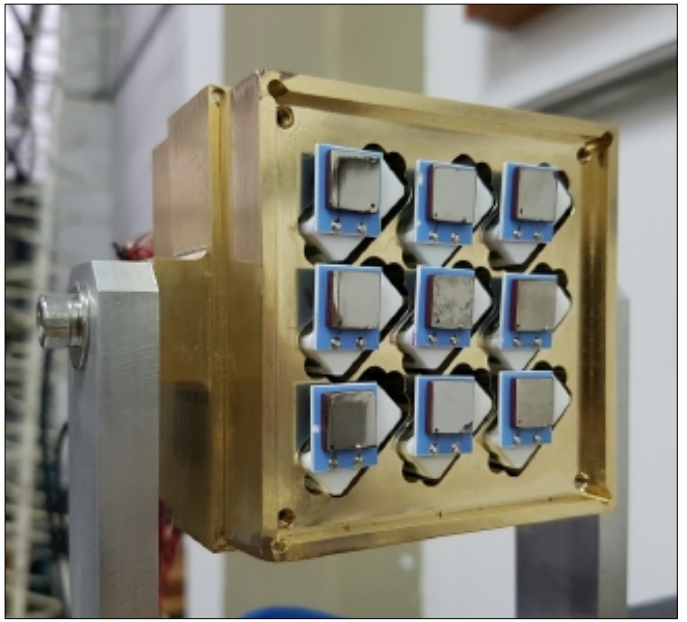
CARACTERIZAÇÃO DO SISTEMA IMAGEADOR DO PROTOMIRAX

→ ONTEM

$$^{241}_{95}\mathrm{Am} \xrightarrow{432{,}2\mathrm{y}} {}^{237}_{93}\mathrm{Np} + {}^{4}_{2}\alpha^{2} + \gamma 59{,}5\,\mathrm{keV}$$

Testes de calibração





CARACTERIZAÇÃO DO SISTEMA IMAGEADOR DO PROTOMIRAX

→ **IMAGENS** (Workshop 2017)

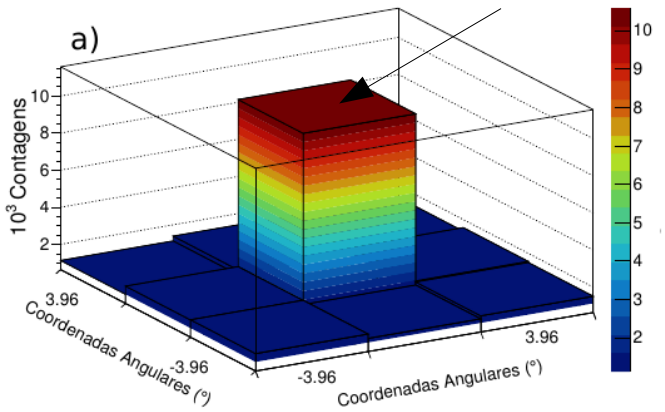
→ Sensibilidade angular

centro

deslocada de
1 sky-bin

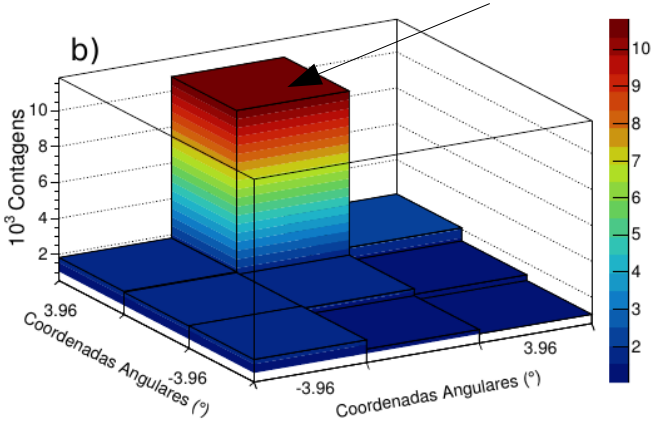
SNR ~ 30

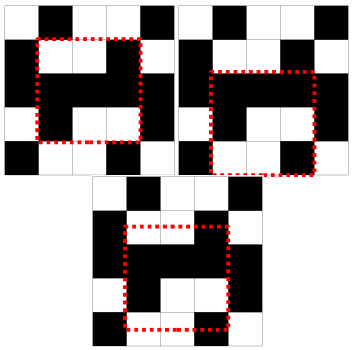
~10k



SNR ~ 30

~10k

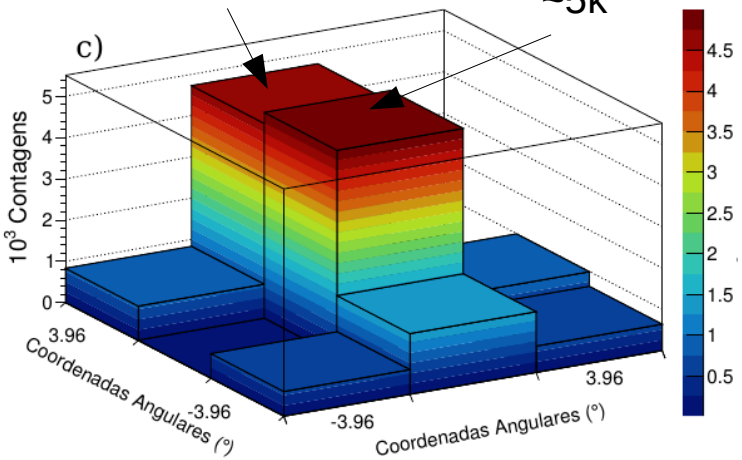




~5k

~5k

SNR ~ 2,5



deslocada de
½ sky-bin

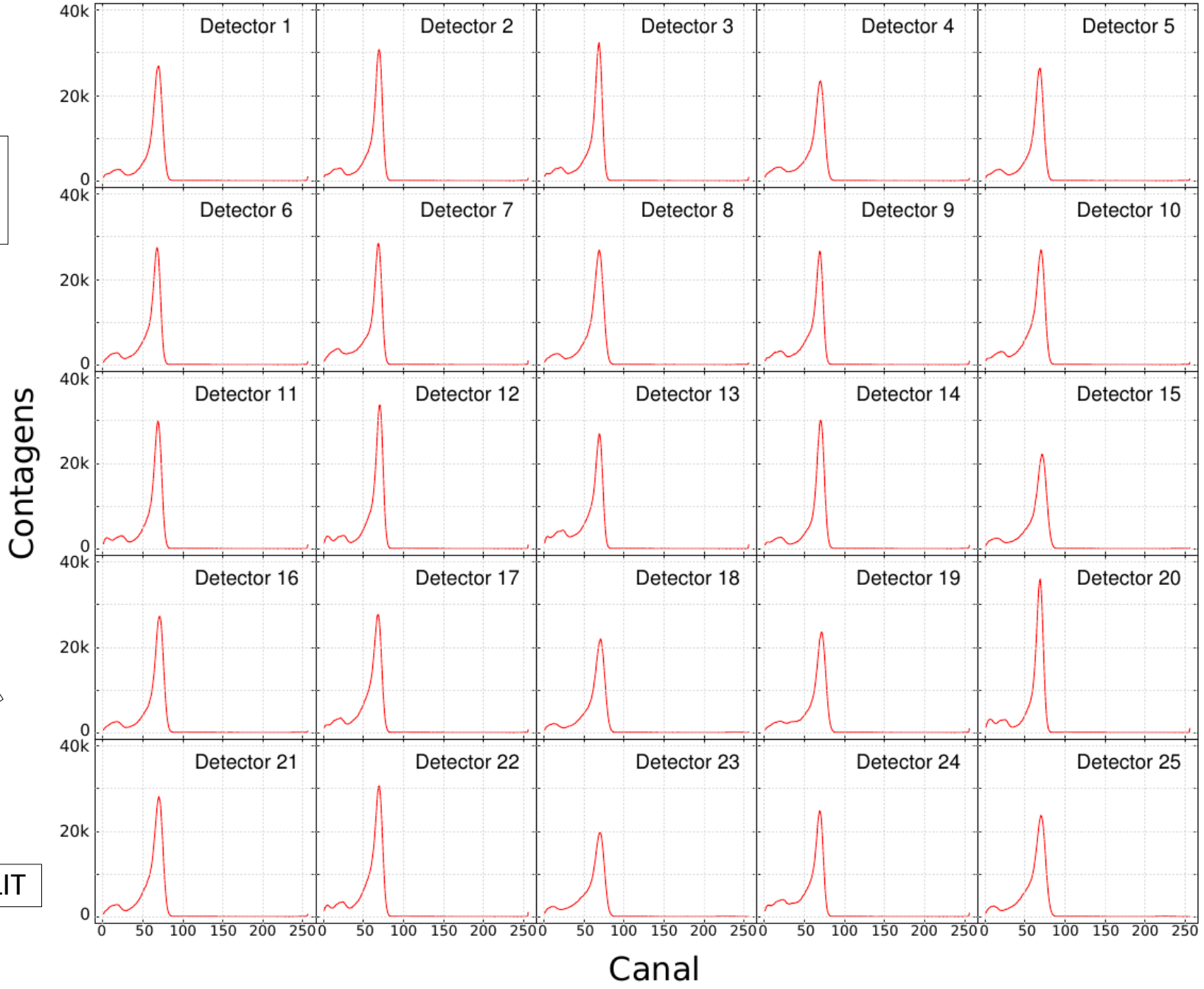
A soma das contagens dos dois picos em c) resulta nas contagens dos picos únicos em a) e b)

O valor total de contagens dos picos – para o mesmo tempo de integração – permanece constante

CARACTERIZAÇÃO DO SISTEMA IMAGEADOR DO PROTOMIRAX

→ HOJE

30 detectores prontos
(na imagem, 25)



20 horas →

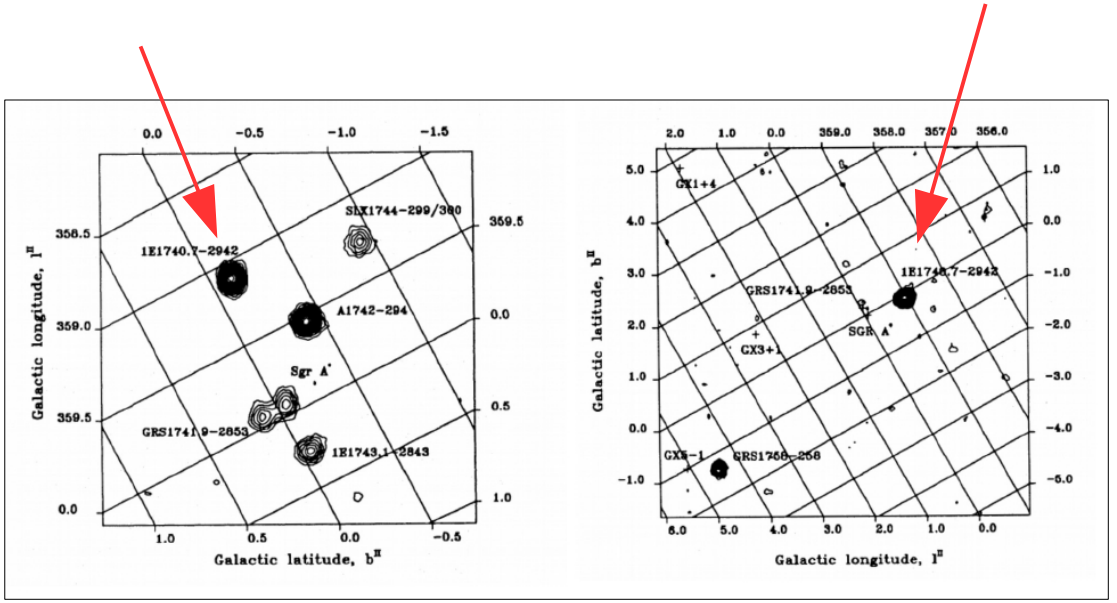
→ Testes no LIT

ANÁLISE TEMPORAL DE 1E 1740.7-2942

→ A FONTE

(Workshop 2017)

- Candidato a **buraco negro –** similaridades com Cyg X-1 (Sunyaev et al., 1991)
  - **Microquasar –** jatos em rádio (Mirabel et al., 1992)
- Brilhante em **raios X duros –** mais brilhante do Centro Galáctico
- Maior parte do tempo no estado **low/hard** de emissão (Santo et al., 2005)
- Contrapartida **não** confirmada
  - LMXB?
  - HMXB?
- Estudo temporal (Smith et al., 2002)
  - **~12,73** dias
    - Período orbital?



Fonte: Sunyaev et al. (1991)

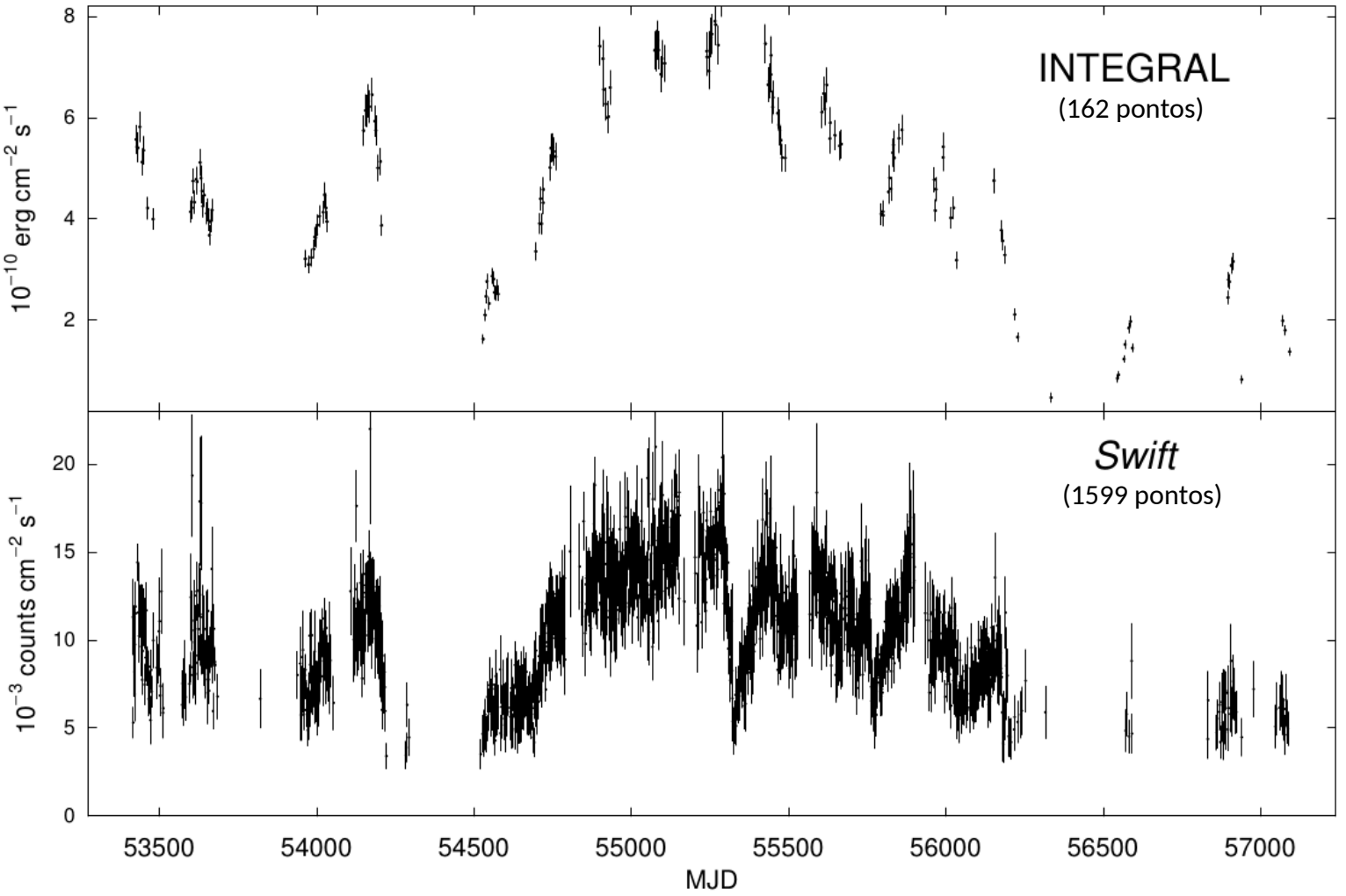
ANÁLISE TEMPORAL DE 1E 1740.7-2942

→ OS DADOS

- 2 telescópios imageadores em raios X duros
  - ISGRI (INTEGRAL)
  - BAT (*Swift*)
- Seleção
  - Low/hard

→ ~10 anos

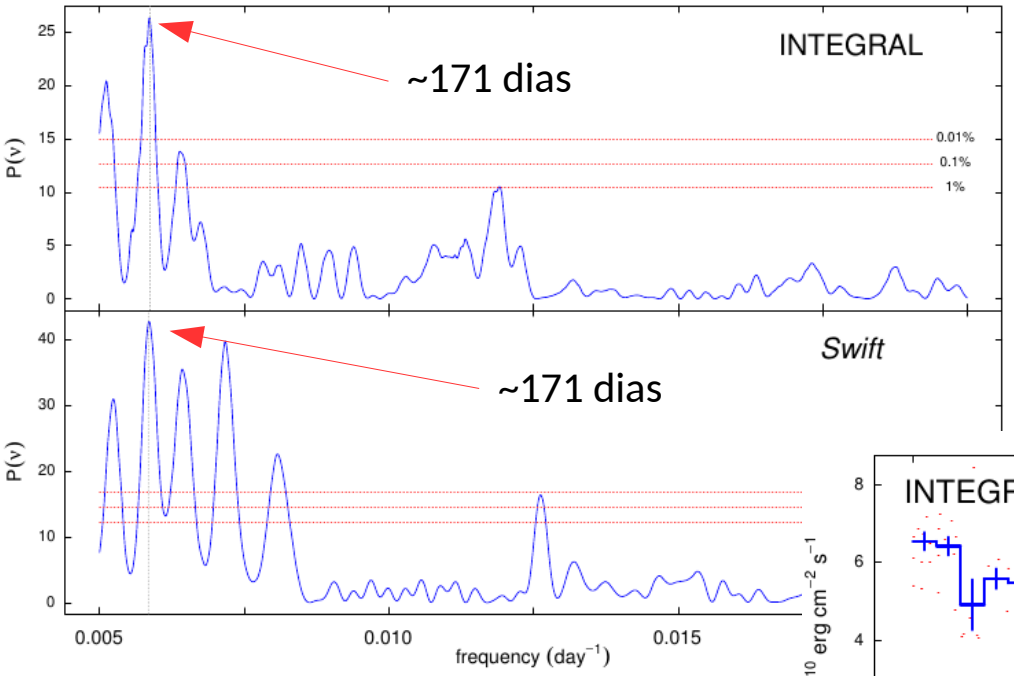
(2005 a 2015)



(Workshop 2017)

ANÁLISE TEMPORAL DE 1E 1740.7-2942

→ **OS RESULTADOS –** período superorbital (Workshop 2017)

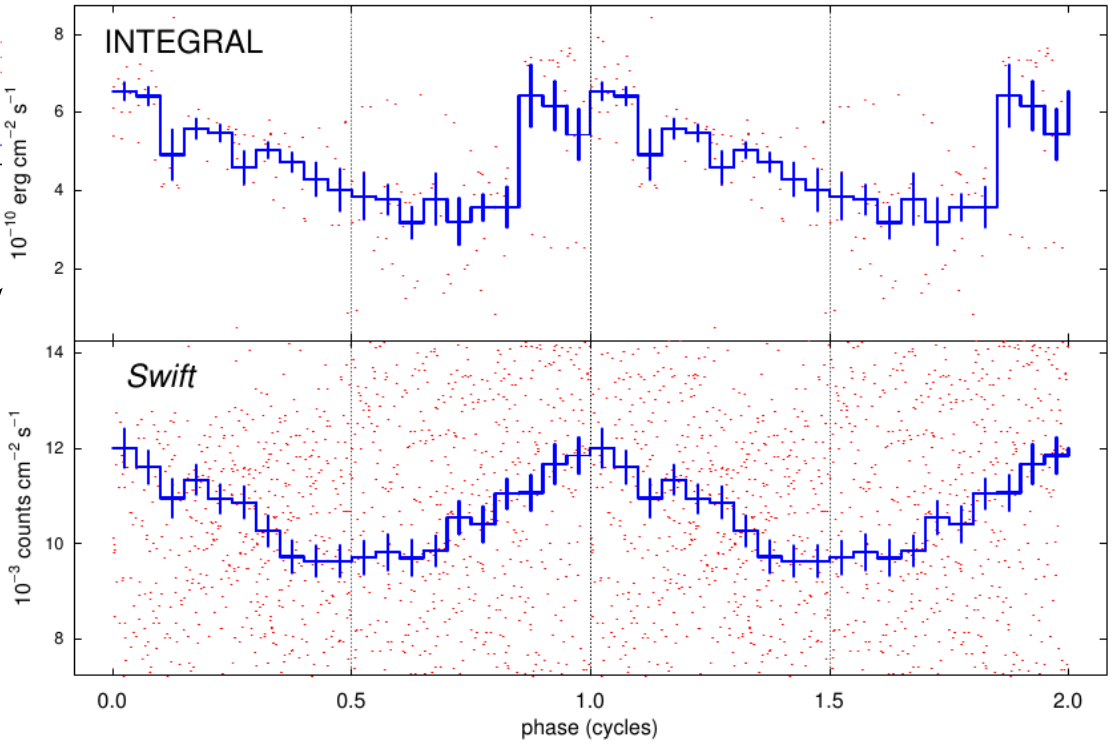


Periodograma de Lomb-Scargle

…
Cross-spectrum

P = 171,1 dias

Diagrama de fases



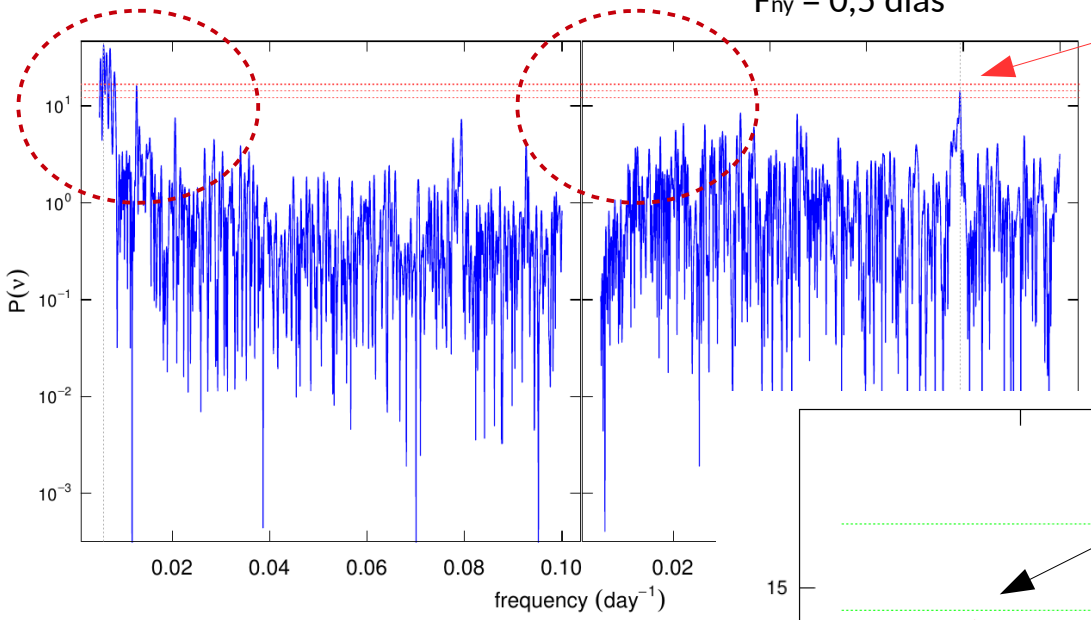
ANÁLISE TEMPORAL DE 1E 1740.7-2942

(Workshop 2017)

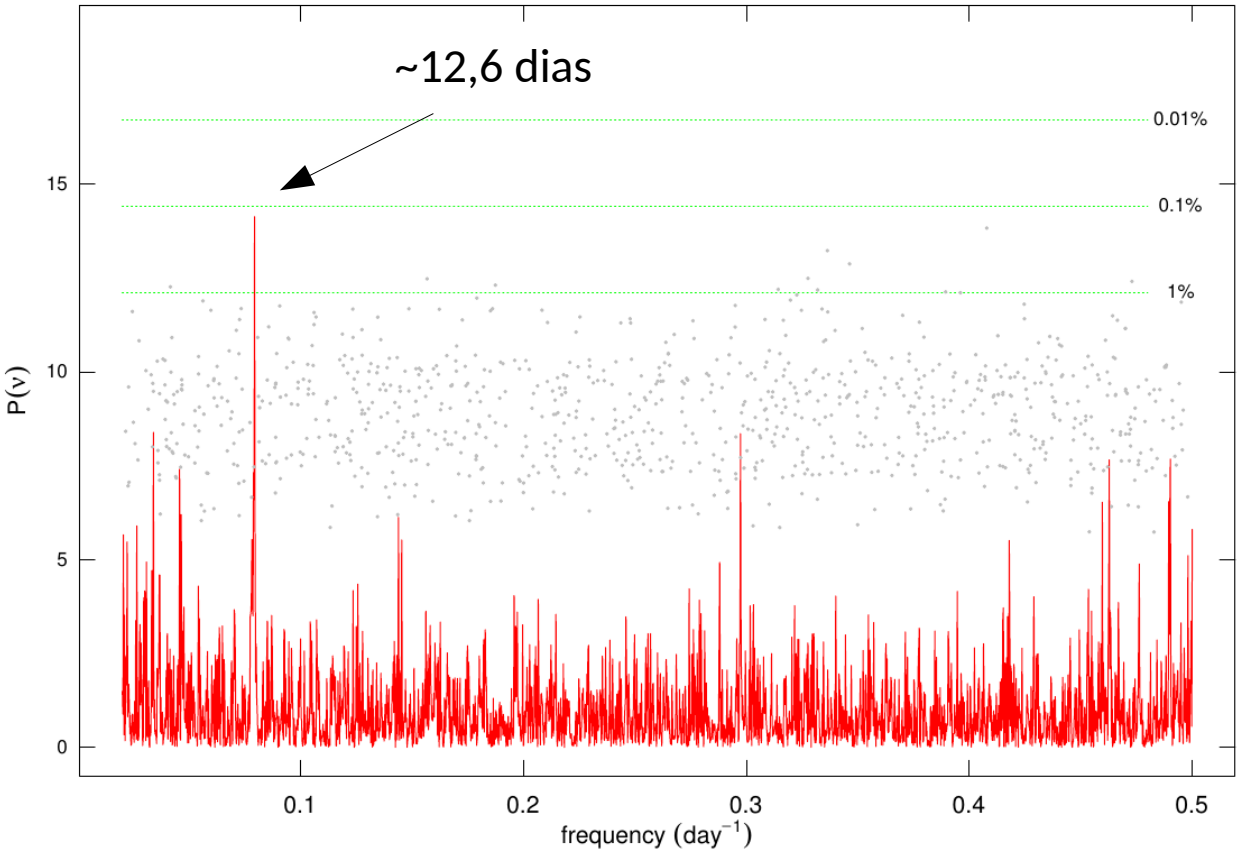
→ **OS RESULTADOS –** período orbital **(dados SWIFT)**

F_{ny} = 0,5 dias^{-1}

algo!



SCRAMBLING:
embaralhamento de pares de pontos – mantendo instantes originais



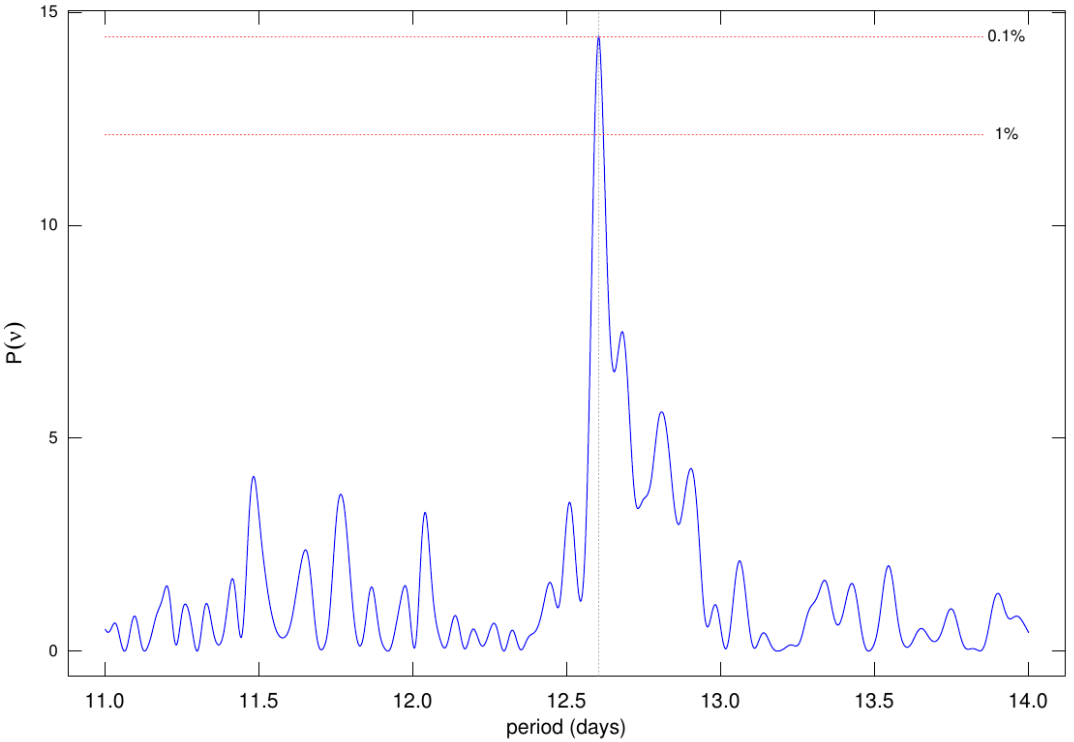
DETRENDING:
remoção de tendências e modulações de baixas frequências

ANÁLISE TEMPORAL DE 1E 1740.7-2942

→ OS RESULTADOS

- **~12,6 dias** → 12,73 dias reportado por Smith et al. (2002)
  - Período orbital
    - → Binária de alta massa

- **~171,1 dias** → nunca reportado
  - Período superorbital
    - Precessão do disco de acreção
      → Obscurecimento da região emissora



(Workshop 2017)

ANÁLISE TEMPORAL DE 1E 1740.7-2942

→ ... (Esse é novo mesmo)

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CrossMark

Tandem *Swift* and *INTEGRAL* Data to Revisit the Orbital and Superorbital Periods of 1E 1740.7–2942

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Received 2017 May 4; revised 2017 May 30; accepted 2017 June 7; published 2017 June 30

Abstract

The black hole candidate 1E 1740.7−2942 is one of the strongest hard X-ray sources in the Galactic Center region. No counterparts in longer wavelengths have been identified for this object yet. The presence of characteristic timing signatures in the flux history of X-ray sources has been shown to be an important diagnostic tool for the properties of these systems. Using simultaneous data from NASA's *Swift* and ESA's *INTEGRAL* missions, we have found two periodic signatures at 12.61 ± 0.06 days and 171.1 ± 3.0 days in long-term hard X-ray light curves of 1E 1740.7−2942. We interpret those as the orbital and superorbital periods of the object, respectively. The reported orbital period is in good agreement with previous studies of 1E 1740.7−2942 using NASA's *RXTE* data. We present here the first firm evidence of a superorbital period for 1E 1740.7−2942, which has important implications for the nature of the binary system.

Key words: stars: individual (1E 1740.7-2942) – X-rays: binaries

Supporting material: data behind figure

Determinação de parâmetros dinâmicos de 1E 1740.7-2942 apenas com o espectro de raios X

Brand new!

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NuSTAR AND *SWIFT* OBSERVATIONS OF THE VERY HIGH STATE IN GX 339-4:
WEIGHING THE BLACK HOLE WITH X-RAYS

M. L. PARKER[1], J. A. TOMSICK[2], J. A. KENNEA[3], J. M. MILLER[4], F. A. HARRISON[5], D. BARRET[6], S. E. BOGGS[2], F. E. CHRISTENSEN[7], W. W. CRAIG[2,8], A. C. FABIAN[1], F. FÜRST[5], V. GRINBERG[9], C. J. HAILEY[10], P. ROMANO[11], D. STERN[12], D. J. WALTON[12], AND W. W. ZHANG[13]

- ***Continuum-Fitting Method***

  Modelo que descreve o espectro térmico de um disco de acreção em volta de um buraco negro de *Kerr* (c/ rotação!)

  Depende de: M, $\dot{M}$, D, i e a_*

- ***Spectroscopy Reflection Method (or Iron line Method)***

  Estudo do espectro de reflexão e da linha do ferro (6,4 keV)

  Independente de M e D e pode inferir diretamenta i e a_*

APENAS RAIOS X

$9.0^{+1.6}_{-1.2}\ M_\odot$

8.4 ± 0.9 kpc

Mas já se sabia que:

$M > 5.8\ M_\odot$

$d > 7$ kpc

+ medidas independentes de i, a, etc

ANÁLISE TEMPORAL DE 1E 1740.7-2942

→ A FONTE

(Workshop 2017)

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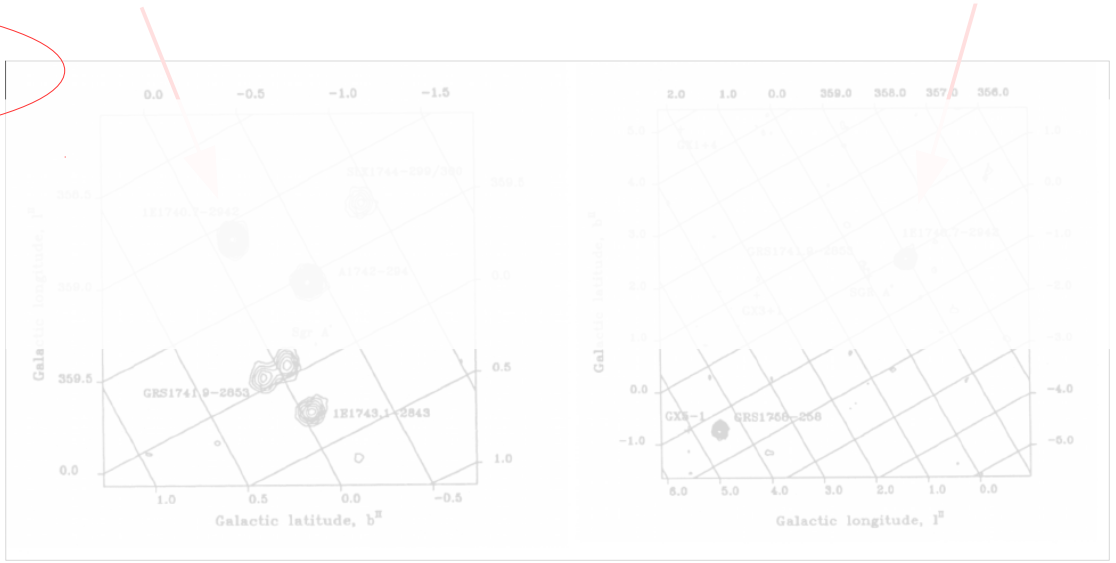


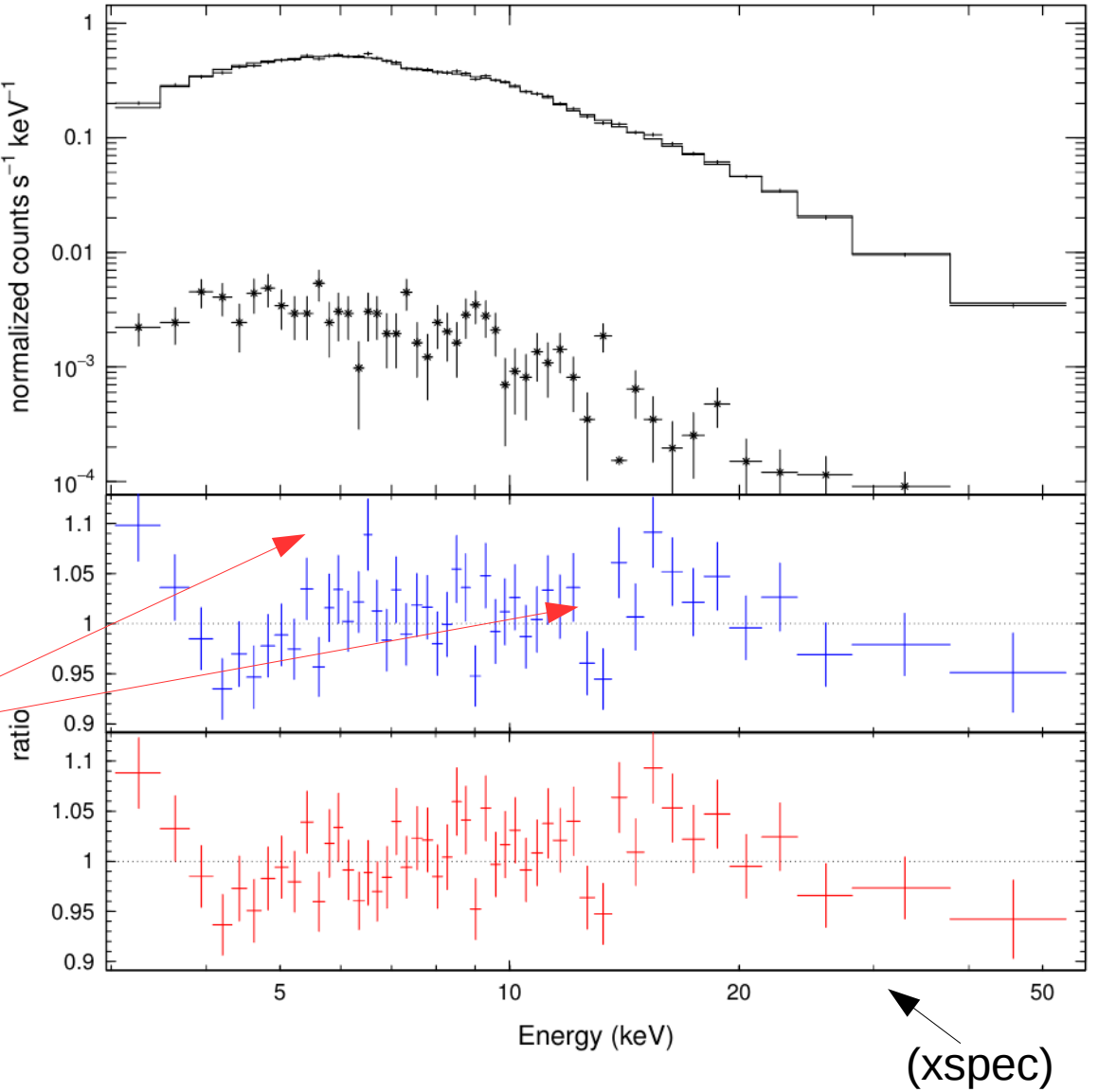
Fonte: Sunyaev et al. (1991)

Determinação de parâmetros dinâmicos de 1E 1740.7-2942 apenas com o espectro de raios X

Brand new!

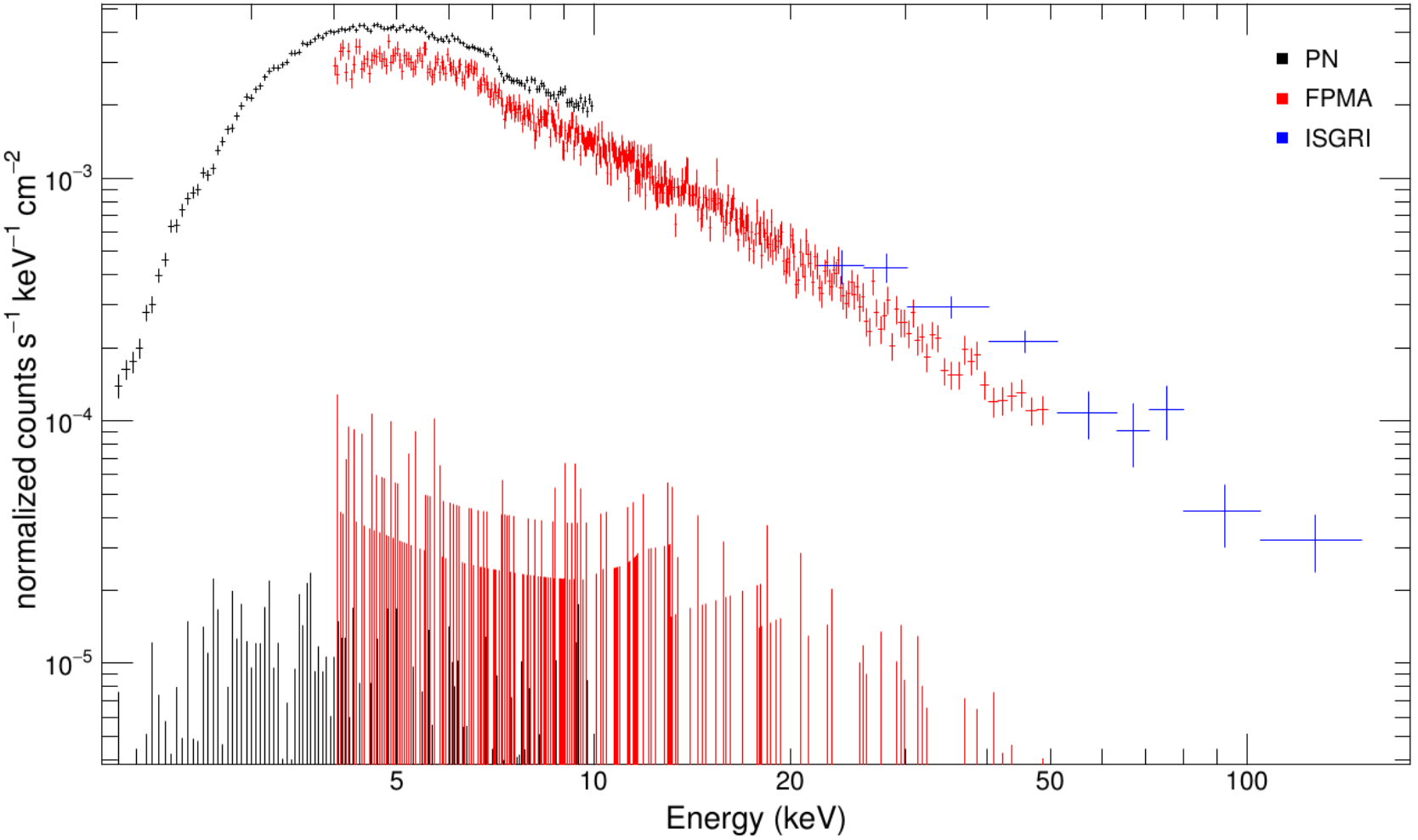
- Acredita-se que ela está no Centro Galáctico (~8,5 kpc)
- Estudos em rádio sugerem alta inclinação (> 60°)
  (Mirabel, 1992)

- NuSTAR, ~10 ks espectro de reflexão + linha do ferro
- XMM + INTEGRAL



(xspec)

Determinação de parâmetros dinâmicos de 1E 1740.7-2942 apenas com o espectro de raios X



Draft version April 24, 2018
Preprint typeset using LaTeX style AASTeX6 v. 1.0

A 4 $M_\odot$ BLACK HOLE IN 1E 1740.7−2942 BASED ON X–RAY SPECTRA WEIGHTING

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Manuel Castro, and João Braga
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ABSTRACT

1E 1740.7−2942 is one of the strongest hard X-ray emitters around the Galactic Center region, believed to be a high-mass X-ray binary and a black hole candidate. The lack of any known counterpart prevents the mass function $f(M)$ of the system from being determined. Modern developments in modeling broad band X-ray spectrum with the presence of a broadened iron line may open the possibility of weighting black holes with only X-ray data. Here we gather public data of 3 different missions to produce a broad band spectrum of 1E 1740.7−2942. NuSTAR data suggest the presence of an iron line and a reflection component, and wide band coverage was achieved including data from XMM and INTEGRAL. Results point to a X–ray source compatible with 4 $M_\odot$, and thus a black-hole. Black hole masses in X-ray binaries measurements up to date show a gap for masses below 10 $M_\odot$. If the mass found in this study is further confirmed, 1E 1740.7−2942 might be one of the first to fill that gap.

Keywords: X-rays: binaries — Stars: individual (1E 1740.7-2942)

OBRIGADO!