Scientific highlights from the NICER mission

<u>Sebastien Guillot</u> (IRAP)



Credits: NASA/GSFC

What is NICER?

PI: Keith Gendreau d.PI: Zaven Arzoumanian

Where is NICER?

Credits: NASA/GSFC

What is NICER?





the Alt



NICER combines the capabilities of Swift and XMM-Newton in a single instrument

- Sensitivity to μ Crab sources: ~ 5 × 10⁻¹⁴ erg/s/cm² (10 ksec, 5 σ)
- High-data throughput (> 1 Crab)
- CCD-like spectral resolution (8% at 1 keV, 2% at 6 keV)



- 1° per second slew
- ~100 nsec time-tagging of events
- 6' non-imaging field of view
- Scheduling flexibility / efficiency
- ToO response time:
 - 5 min for MAXI Triggers (automated)
 - 4h during business hours

Rapid slew permits efficient scheduling, e.g., for coordinated observations or recurrent visits.



Credits: NASA/NICER

NICER's dynamic range is unmatched.



Credits: NASA/NICER

MAXI J1820+070

+ 22 refereed publications using NICER data*

<u>See talks by</u> Andrzej Zdziarski Barbara De Marco Alessio Marino

* mention NICER in the title/abstract

MAXI J1820+070 — A contracting corona (in the hard state)

- Reverberation lags become x10 shorter over 40 days
- FeK line shape remains constant, but EW decreases
- So change in irradiation corona, rather than the disk itself.







MAXI J1820+070 — The coronal expansion (during transition)



Wang et al. (2021)

MAXI J1820+070 — QPO changes and a radio flare



Switch of QPO (C to B) Confirm the link between jet launches and B-type QPOs (no physical model proposed yet)

Homan et al. (2019)

In the hard-to-soft transition:

- Reduction of X-ray variability
- Small hard X-ray flare
- strong radio flare afterwards



<u>GRS 1915+105</u>: Timing spectroscopy during decay and a brief flare



- Decay typical of the end of outbursts
- Absorption lines during decay and re-flare
- Emission lines in the hard state.

Nielsen et al. (2019, 2020) Koljonen et al. (2021)



Time Since Start (s)

MAXI J1535–571 — Repeated re-flaring episodes



Re-flares show similar characteristics as main outburst
Same physical mechanism, event at x100 lower luminosity

Cuneo et al. (2019)

<u>4U 1543-37</u> — The BH transient of the decade



- Close to 100,000 c/s
- No pileup but telemetry saturation
- ◆ Deactivation of some detectors to maintain telemetry at a few 10⁴ c/s

Connors et al. (2021)

BH in the mass gap, and the NS maximum mass



The NS maximum mass depends on the equation of state

BH in the mass gap, and the NS maximum mass



The NS maximum mass depends on the equation of state

AT2018cow – A NS or a BH?



- → $M < 850 M_{\odot}$ required by causality
- Newly formed NS (but there are challenges)
- Stellar mass BH, but a bit unusual

One of the brightest FBOT (Fast Blue Optical Transient)
QPO: f ~ 224 ± 1 Hz



Quasi Periodic Eruptions from a quiescent galaxy



• eRO-QPE1: discovered by eROSITA

Follow-up with NICER: 1 spectrum every 90 min for 11 days!

Candidate for extreme mass-ratio inspirals

CO inspiral onto SMBH

Arcodia et al. (2021)

Mrk 871 — Evolution of a disk wind

- Highly absorbed in the X-ray
- Blue-shifted UV
 absorption lines
- Drop in flux driven by increased absorption, correlated with EW of the absorber



1ES 1927+654 — Changing-look AGN behaving like a BH transient



- The power-law component disappears, then reappears:
 - Debris interaction with the disk
 - Increased the accretion rate
 - Suppressed corona
 - The disk then refills and the corona reforms



Trakhtenbrot et al. 2019 Ricci et al. 2020, 2021

Conclusions

- They were possible thanks to :
 - Capabilities to return to a source regularly
 - Obtain CCD-like spectroscopy
 - In the full 0.5–10 keV soft X-ray band
 - Possibility to handle tens of thousands of cts/sec

Apologies if I didn't mention your favorite NICER result

Upgrading NICER with OHMAN, the On-orbit Hookup of MAXI and NICER

TRIGGE

Reaction time on MAXI triggers drop from several hours (at best) to a few min





NICER

You want to use NICER?

- Many analysis threads online (at HEASARC) using NICERDAS
- Background modelling tools :
 - hibackgen3C50, nicer_bkg_estimator
- NICERsoft (un-official package with all-in-one diagnostics and filtering capabilities)
- Working with bright sources ?
 - De-activate some detectors.

In 2022, the proposal deadline is on Sept. 7th

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1.6	15	3-6	26	4-6	36	5.7	56
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1.4	13	3.4	33	5.4	53	7.7	67
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