Scientific highlights from the NICER mission

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What is NICER?

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Where is NICER?
What is NICER?
NICER combines the capabilities of Swift and XMM-Newton in a single instrument

- Sensitivity to $\mu$Crab sources: $\sim 5 \times 10^{-14}$ erg/s/cm$^2$ (10 ksec, 5$\sigma$)
- High-data throughput (> 1 Crab)
- CCD-like spectral resolution (8% at 1 keV, 2% at 6 keV)

- 1° per second slew
- $\sim$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

Credits: NASA/NICER
Rapid slew permits efficient scheduling, e.g., for coordinated observations or recurrent visits.
NICER’s dynamic range is unmatched.

Credits: NASA/NICER
MAXI J1820+070

+ 22 refereed publications using NICER data*

See talks by
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.

Kara et al. (2019)
MAXI J1820+070 — The coronal expansion (during transition)

- $H_{\text{corona}}$ from reltrans
- Reverberation lags increase, so the corona is expanding
- Followed by jet ejection

Wang et al. (2021)
MAXI J1820+070 — QPO changes and a radio flare

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

In the hard-to-soft transition:
- Reduction of X-ray variability
- Small hard X-ray flare
- Strong radio flare afterwards
GRS 1915+105: 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)
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)
4U 1543-37 — 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 $10^4$ 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?

- One of the brightest FBOT (Fast Blue Optical Transient)
- QPO: $f \sim 224 \pm 1$ Hz
- $M < 850 \, M_{\odot}$ required by causality
- Newly formed NS (but there are challenges)
- Stellar mass BH, but a bit unusual

Pasham et al. (2022)
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

CAUTION: eRO-QPE1: 2MASS 02314715-1020112
Mean separation ~ 0.8 d

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

Kara et al. (2021)
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
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

Reaction time on MAXI triggers drop from several hours (at best) to a few minutes.
You want to use NICER?

- Many analysis threads online (at HEASARC) using **NICERDAS**
- Background modelling tools:
  - nibackgen3C50, 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