Charge exchange emission from comets with NICER

Emanuele Bonamente

Physics Department, Auburn University

NICER: the Neutron Star Interior Composition Explorer

X-ray emission from comets
Comets are fast-moving objects with faint X-ray emission produced by charge exchange between solar wind highly ionized particles and neutrals in the coma

Background estimate
NICER is characterized by a variable background that depends on the position (geomagnetic latitude) and the sun (space weather), requiring a specific and detailed estimate for each observation
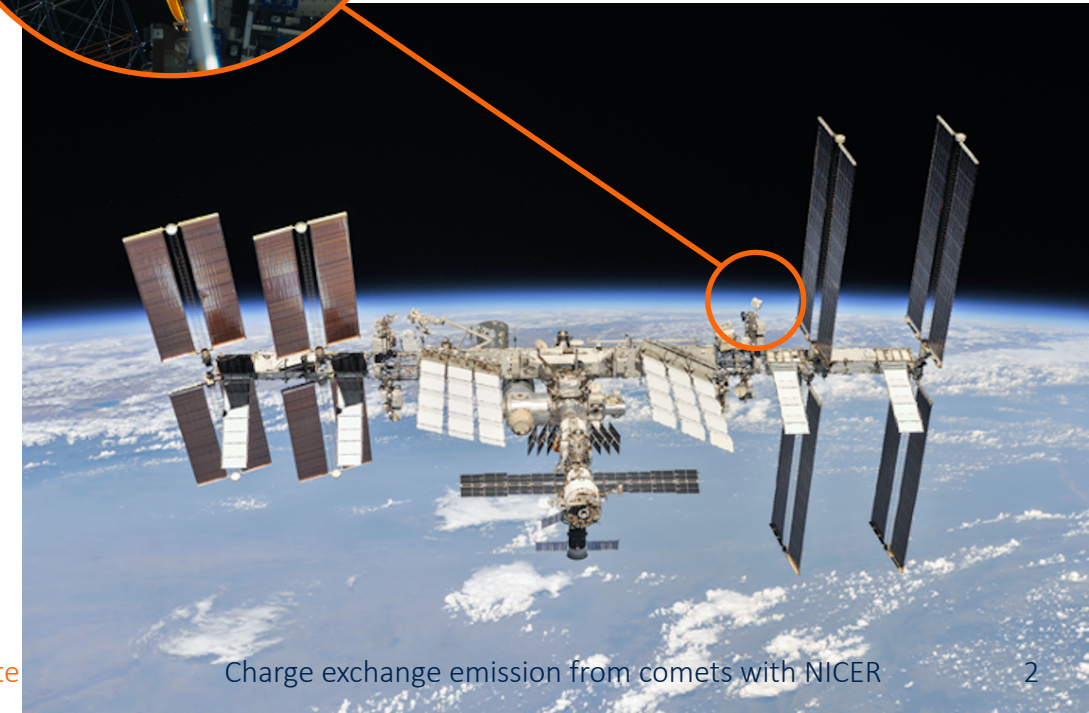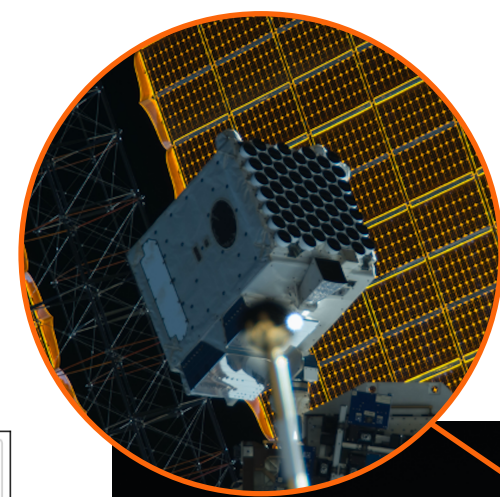
Observation strategy
33 observations at the comet: pre-target – on-target – post-target
17 used after selection
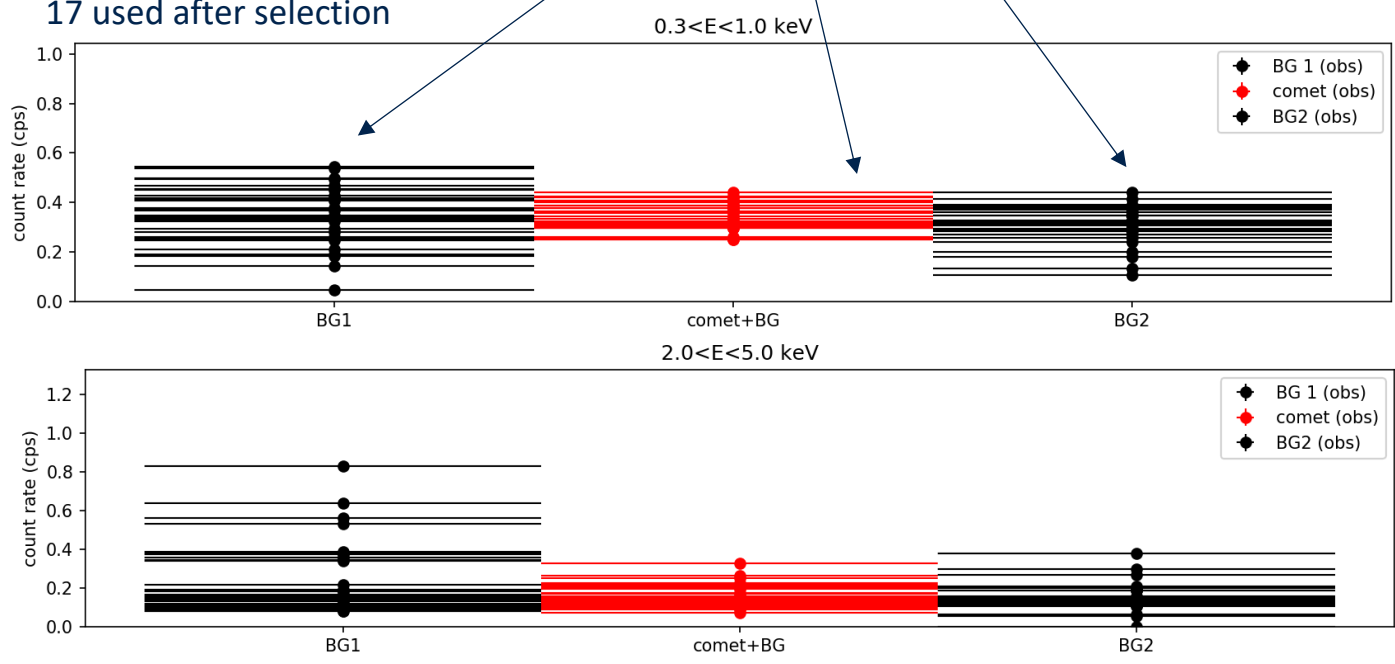
Non-imaging X-ray spectrometer (0.2-12 keV) located onboard the ISS.
The X-ray Timing Instrument (XTI) is an array of 56 concentrator optics and silicon-drift detectors pairs.

- Sensitivity: 3×10^{-14} ergs s^{-1} cm^{-2} (0.5-10 keV, 5 σ in 10 ksec)
- Field of view: 30 arcmin^2
- Effective area: 1900 cm^2 at 1.5 keV
- Time resolution: 100 ns

CX emission from comet C/2017 T2 (PANSTARRS)

Event selection

- similar ISS positions with respect to the Earth magnetic field
- consistent count rates in target and post-target observations at high energies
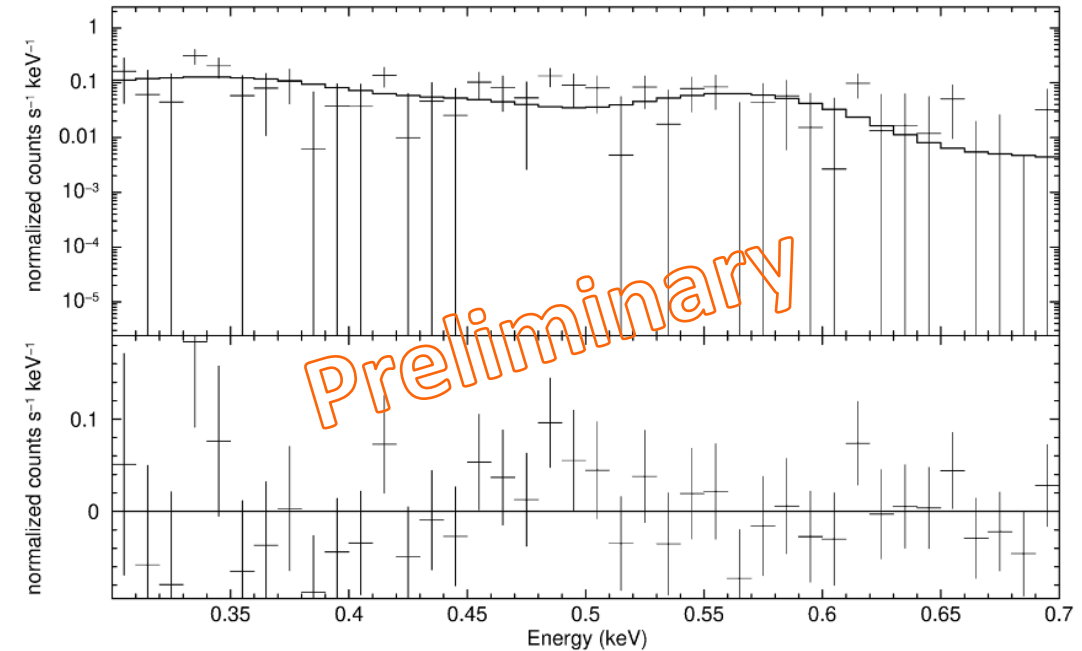
BG-subtracted spectrum

- Low energy (0.3<E<1 keV) excess: 870±150 counts (>5σ)
- High energy (2<E<5 keV): -14±100 counts

Fit results (preliminary)

vacx2 model in energy range 0.3<E<0.7 keV using only C, N, and O

75% fit probability using:

- solar wind velocity v=750 km/s
- plasma temperature of T =10^6 K

Flux = 2.0x10^{-14} ergs s^{-1} cm^{-2}, 68% C.I. is (1.9-2.5)x10^{-14} ergs s^{-1} cm^{-2}

Goals

- Identification of a reliable and reproducible strategy for future comet observations using NICER.
- Proof of CX spectrum analysis as a reliable probe of space solar wind parameters, especially at high heliographic latitudes where it is not continuously monitored.
- Combine X-ray to optical and ultraviolet information in order to constrain on coma composition and morphology properties

Ongoing investigations and future developments

- Improvements on background estimate and subtraction procedure (i.e. enhanced cuts on good events and good time intervals).
- Refinement of the fitting model and test against alternative hypotheses.
- Scheduled observation of the periodic comet 88P/Howell with NICER starting September 2020. The analysis will allow the comparison between polar and equatorial wind CX emission.