The ESA investigation ASIM examines the role of severe thunderstorms in Earth's atmosphere. NASA ID: iss057e080464.

Publication Highlights

Earth and Space Science

The position of the space station in low-Earth orbit provides a unique vantage point for collecting Earth and space science data. From an average altitude of about 400 km, details in such features as glaciers, agricultural fields, cities, and coral reefs in images taken from the ISS can be combined with data from orbiting satellites and other sources to compile the most comprehensive information available. Even with the many satellites now orbiting in space, the ISS continues to provide unique views of our planet and the universe.

The NASA investigation [Neutron star Interior Composition Explorer (NICER)]() is designed to observe the structure, physical properties, and changes of neutron stars.

In a new study published in *The Astrophysical Journal Letters*, a short burst from the soft gamma-ray repeater Swift J1555.2-5402 was detected by the Burst Alert Telescope (BAT) on June 3, 2021. Monitoring began 1.6 hours after the burst using the NICER telescope. In one month of monitoring, BAT detected 5 bursts and NICER detected 45 bursts. One hard x-ray of strong energy was detected by the Nuclear Spectroscopic Telescope Array (NuSTAR).

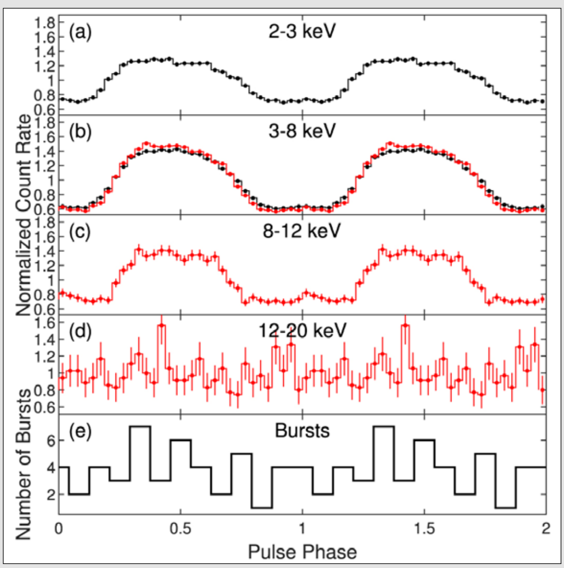

Figure 24. X-ray pulses of Swift J1555.2-5402 in different energy bands, NICER data points in black, NuSTAR data points in red. Image adopted from Enoto, The Astrophysical Journal Letters.

Pulse monitoring with NICER provided a time-series capability as well as the ability to examine the physical properties of Swift J1555.2-5402. The physical properties noted were a constant flow of energy with a slight decline at the end of the observation period; a single waveform of soft X-rays, which indicated low energy; temperature decline; a weak magnetic field; and decreased luminosity, indicating loss of energy.

All the measurements obtained suggested that Swift J1555.2-5402 is a young magnetar. Magnetars are highly magnetized neutron stars that are usually bright in X-rays as a result of the release of an enormous amount of magnetic energy. Understanding all the physical properties combined suggested to the researchers that Swift J1555.2-5402 is one of the youngest magnetars ever discovered.

Enoto T, Ng M, Hu C, Guver T, Jaisawal GK, et al. A month of monitoring the new magnetar Swift J1555.2-5402 during an X-ray outburst. The Astrophysical Journal Letters. 2021 October 5; 920(1): L4. DOI: 10.3847/2041-8213/ac2665.

The ESA investigation [EXPOSE-R2 Biology and Mars Experiment (BIOMEX)]() examines the survival of organisms in the extreme environment of space.

Improving microbial-based technologies is critical to the advancement of space exploration. Complex symbiotic interactions between microbes in artificial ecosystems can allow for oxygen production, conversion to organic compounds, water purification, waste recycling, and food production. Developing capabilities to live off

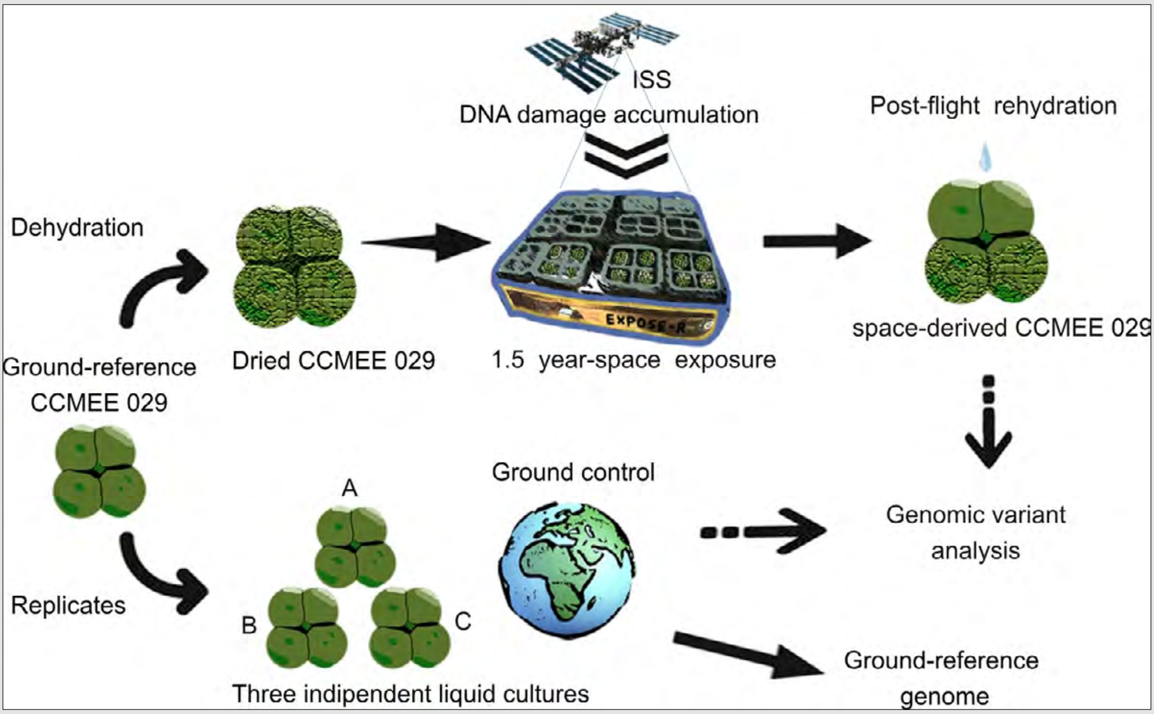

Figure 25. Experiment design of EXPOSE-R2 BIOMEX. Image adopted from Napoli, Scientific Reports.

the land would enable humans to create self-sustaining habitats on the Moon or on Mars.

Previous studies have demonstrated the survivability of bacterial spores in deep space and during long-term space exposure. Desiccated bacteria have also been found to retain their function upon reactivation after spaceflight. In this new study published in *Scientific Reports*, the desert cyanobacterium *Chroococcidiopsis*, known to be highly resistant to harsh environments and adequate for genetic manipulation, was flown to the EXPOSE facility of the ISS where dried cells were mixed with Martian regolith as nutrient source and exposed for 1.5 years to simulated Mars-like conditions (i.e., cosmic radiation, cold temperatures, and atmospheric pressure).

A strain of the *Chroococcidiopsis* genus derived in space was rehydrated and examined for its genomic alterations and DNA robustness once back on Earth. Genomic sequencing showed no increased variants in the space strain compared to ground strains, demonstrating that the space-derivate strain did not involve any known proteins of DNA repair pathways. This finding suggested to the researchers that the space-derivate strain retained the ability to repair accumulated DNA lesions caused by radiation. These findings advance the possible use of cyanobacteria for artificial bioregenerative life support systems that provide oxygen and food as well as biotechnological applications in fuel, fertilizers, marine farming, and pharmaceutical production.

Napoli A, Micheletti D, Pindo M, Larger S, Cestaro A, et al. Absence of increased genomic variants in the cyanobacterium Chroococcidiopsis exposed to Mars-like conditions outside the space station. Scientific Reports. 2022 May 19; 12(1): 8437. DOI: 10.1038/s41598-022-12631-5.

Publication Highlights

Earth and Space Science

The JAXA investigation [Monitor of All-sky X-ray Image (MAXI)](), which contains high-precision X-ray detectors, is used to explore the cosmos by continuously tracking the appearance of random and short-lived X-ray phenomena. Upon early detection of an event, MAXI notifies other observatories and satellites for follow-up observations. Operations began in 2009.

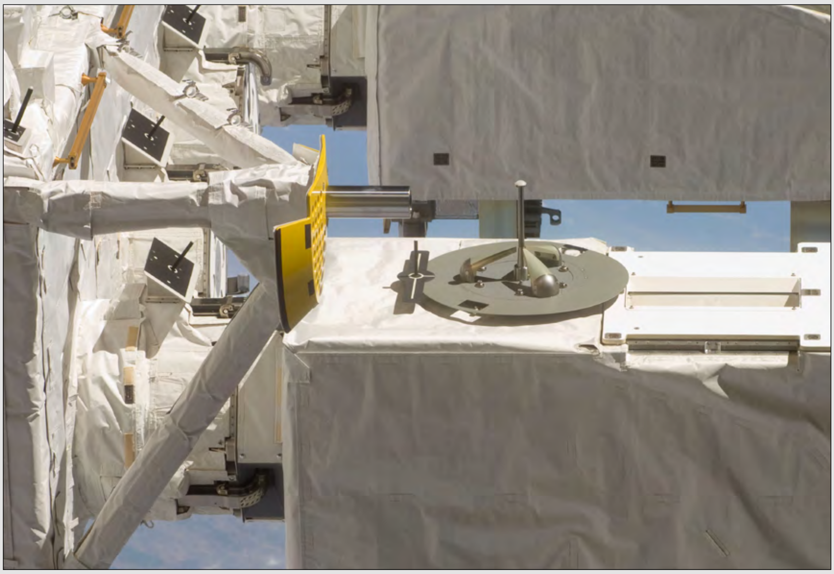

Figure 26. MAXI installed aboard the ISS. NASA ID: s127e009561.

Compact objects such as Neutron Stars and black holes undergo cycles of luminosity states that include outbursts and periods of quiescence. In a new study published in *The Astrophysical Journal*, MAXI and NuSTAR detected a new faint X-ray in the cluster GLIMPSE-C01 and named the source MAXI J1848015. Based on spectral and timing analyses, the light curve showed an increase and then a decrease in energy, indicating the presence of an accretion disk that extends close to the accretor.

The X-ray spectra changes between a low luminosity (dim) hard state and a high luminosity (bright) soft state. During the dim hard state, X-ray energy emissions originate from the hot plasma in the corona around the star. During the bright soft state, emissions originate from the inner regions of the accretion disk.

Reflection of thermal emissions in the bright soft state was observed and moderate disk truncation was observed in the hard state. The high spin of this source indicated that the observation is a black hole rather than a neutron star. However, the low luminosity of the source is currently unexplained and may be due to many factors, including observational angles or emission scattering from the outer disk.

This work demonstrates how combining MAXI all-sky monitoring with NuSTAR's imaging and spectral capabilities can help to identify compact objects and distinguish between neutron stars and black holes.

Pike SN, Negoro H, Tomsick JA, Bachetti M, Brumback M, et al. MAXI and NuSTAR observations of the faint X-ray transient MAXI J1848-015 in the GLIMPSE-C01 cluster. The Astrophysical Journal. 2022 March 10; 927(2): 190. DOI: [10.3847/1538-4357/ac5258]().

The JAXA investigation [CALorimetric Electron Telescope (CALET)]() is a charge detector able to distinguish between different chemical elements with high resolution.

Publication Highlights

Earth and Space Science

It includes an imaging and a total absorption calorimeter as well as two hodoscopes for observing the paths of high-energy cosmic ray nuclei. The hardware was launched to the ISS in 2015 and is installed on the Japanese Experiment Module Exposure Facility. Analysis of CALET data provides new insight into the source of cosmic rays, the nature of astrophysical energetic particle acceleration mechanisms, and characteristics of the interstellar space in our galaxy.

In a new study published in *Physical Review Letters*, researchers measured the energy spectrum of nickel from November 2015 to May 2021. Nickel is of interest to researchers because it is a highly abundant transition metal in the cosmos and few direct measurements have been reported. The current measurement of nickel follows a previous examination of iron in cosmic rays, expanding the researchers' investigation to obtain data values of several heavy metals. This data will eventually enable the mapping of many different heavy nuclei propagating through space.

The analyses provided a measurement of the energy spectrum of nickel, along with statistical standards to learn about the level of error and certainty in the measurements. A flat nickel-to-iron ratio indicated that the energy spectral shapes of nickel and iron are the same and suggested a similar source and propagation of the nuclei.

Observing the abundance and stability of nickel energy spectra and cosmic rays is key to understanding theoretical accelerations and propagation mechanisms of charged particles in our galaxy.

Adriani O, Akaike Y, Asano K, Asaoka Y, Berti E, et al. Direct measurement of the nickel spectrum in cosmic rays in the energy range from 8.8 GeV/n to 240 GeV/n with CALET on the International Space Station. Physical Review Letters. 2022 April 1; 128(13): 131103. DOI: [10.1103/PhysRevLett.128.131103](https://doi.org/10.1103/PhysRevLett.128.131103).

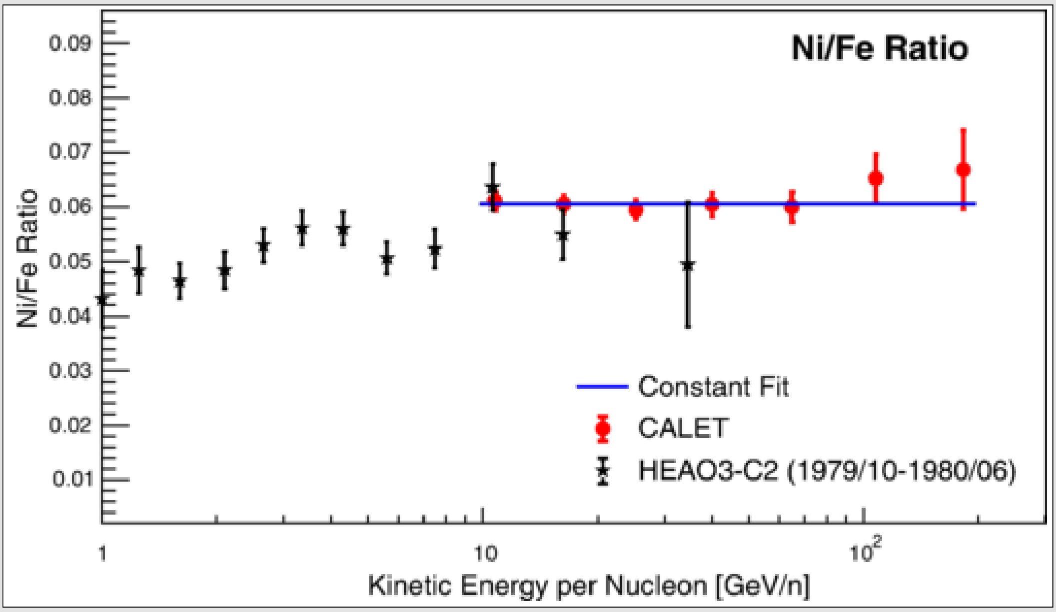

Figure 27. Nickel-to-iron ratio with statistical error bars. Constant fit demonstrates that the energy spectral shapes of the two nuclei are the same. Image adopted from Adriani, Physical Review Letters.