Simultaneous TES readout at level of Athena-like telescopes

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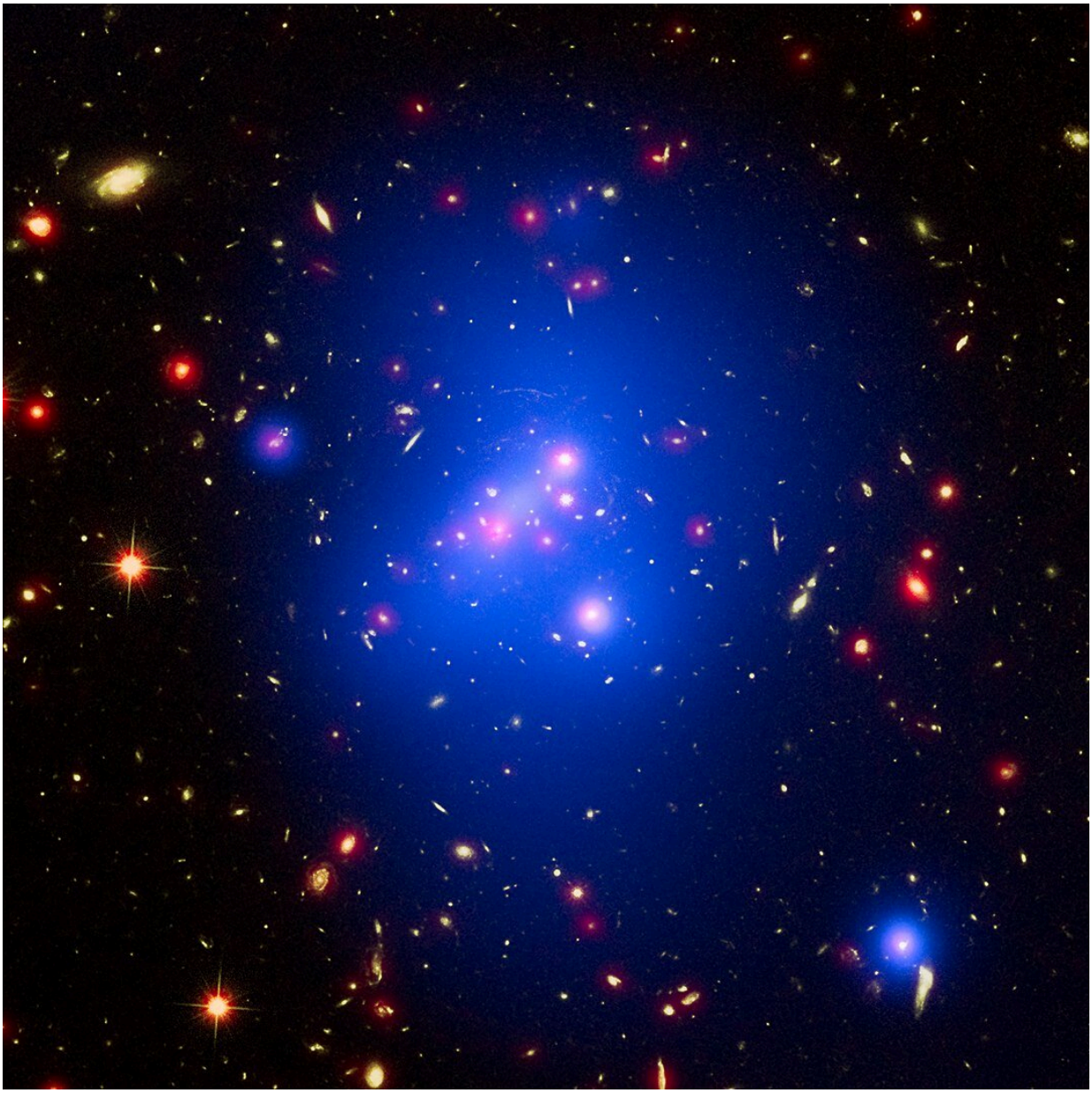

Credit: ESA/Hubble

Scientists at SRON Netherlands Institute for Space Research have simultaneously read out the signal of 37 TES pixels at a resolution of 2.2 eV for X-rays (6 keV). It is the first time that a simultaneous readout fulfills the requirements for future space telescopes at the level of Athena in terms of both number of pixels and energy resolution. In 2020, SRON already set a world record of 1.3 eV energy resolution for X-rays with TES, but only with a single pixel readout.

Transition edge sensors (TES) are developed for space research because they are able to determine the energy of single photons much better than conventional spectrometers; for example, to measure the spectrum of far-away clusters of galaxies. TES detectors operate at temperatures near absolute zero, making them superconducting. By keeping them balanced on the edge of superconductivity and the normal conduction state, they can be used as sensitive thermometers. The energy of a single photon is sufficient to heat up the material enough to tip the balance toward the normal state. This is read out as a change in the current flowing through the detectors, proportional to the energy of the incoming photon.

Because of limited electrical power and cooling power in space, it is necessary for space instruments to read out multiple pixels through the same channel, called multiplexing. SRON develops TES technology based on a system that reads out pixels also simultaneously, called frequency domain multiplexing (FDM). This avoids overheating when each pixel would be read out at the same time through its own wire.

A publication in *Applied Physics Letters*, with first author Hiroki Akamatsu, now describes the demonstration of 37 pixels being read out simultaneously at an energy resolution of 2.2 eV, matching the capability

of Athena's X-IFU instrument. The technology is not scheduled to serve as X-IFU's readout, but can be used for other astronomical projects such as HUBS (soft X-ray, large scale structure mapper) and LiteBird (Cosmic Microwave Background, detecting primordial gravitational wave) as well as ground-based telescopes.

More information: H. Akamatsu et al, Demonstration of MHz frequency domain multiplexing readout of 37 transition edge sensors for high-resolution x-ray imaging spectrometers, *Applied Physics Letters* (2021). DOI: 10.1063/5.0066240

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