DOI: 10.18727/0722-6691/5353

Goodbye SOFI and Thanks for 25 Years of Data!

Emanuela Pompei [1]
Valentin D. Ivanov [1]
Chris Lidman [2]
Ivo Saviane [1]
Leonardo Vanzi [3]

[1] ESO
[2] Siding Spring Observatory, Research School of Astronomy and Astrophysics, Australian National University, Australia
[3] Pontificia Universidad Catolica de Chile, Santiago, Chile

15 August 2023 was the last night of observation with Son OF Isaac (SOFI) at the New Technology Telescope (NTT) in La Silla. The following day, the instrument was warmed up and removed from the NTT's Nasmyth A focus, in preparation for Son Of X-Shooter (SOXS) to be installed in its place.

A little bit of (glorious) history

Son OF Isaac (SOFI; Moorwood, Cuby & Lidman, 1998) was a near-infrared (0.9–2.5 μm) spectro-imager and polarimeter installed at the Nasmyth A focus of the New Technology Telescope (NTT) in 1997; it saw first light on 6 December 1997[1] and entered into operation during 1998. The development of SOFI was exceptionally fast for a new instrument, taking less than two years, since many technical solutions already tested for the Infrared Spectrometer And Array Camera (ISAAC)[2] were adopted, i.e. identical detector acquisition system and control software.

SOFI was conceived as a near-infrared equivalent of the ESO Faint Object Spectrograph and Camera 2 (EFOSC2), a workhorse instrument, and it was dedicated to the exploration of the near-infrared Universe. SOFI was capable of taking images in several narrow- and broad-band filters at different spatial resolutions, and spectra with three slits (0.6, 1 and 2 arcseconds wide), delivering spectral resolutions ranging from R = 1000 to R = 2200 (with the 0.6-arcsecond slit).

A polarimetric capability was also commissioned and offered to users, making SOFI a versatile instrument with better performance than the InfraRed Array Camera 2 (IRAC2) at the MPG/ESO 2.2-metre telescope and the previous InfraRed SPECtrometer (IRSPEC) on the NTT, which SOFI replaced.

The new instrument paved the way for testing and using the Very Large Telescope (VLT) software on the NTT and allowed the regular use of Observing Blocks (OBs); the new Phase 2 tool could then be verified, standardising day and night operations, and leading to greater observing efficiency.

The other novelty with SOFI was to offer the community a new software capable of processing the various observing modes, such as jittered[3] observations, which greatly helped in dealing with the large amounts of data near-infrared instruments can generate. More importantly, it paved the way for the publicly available instrument pipelines that we see today.

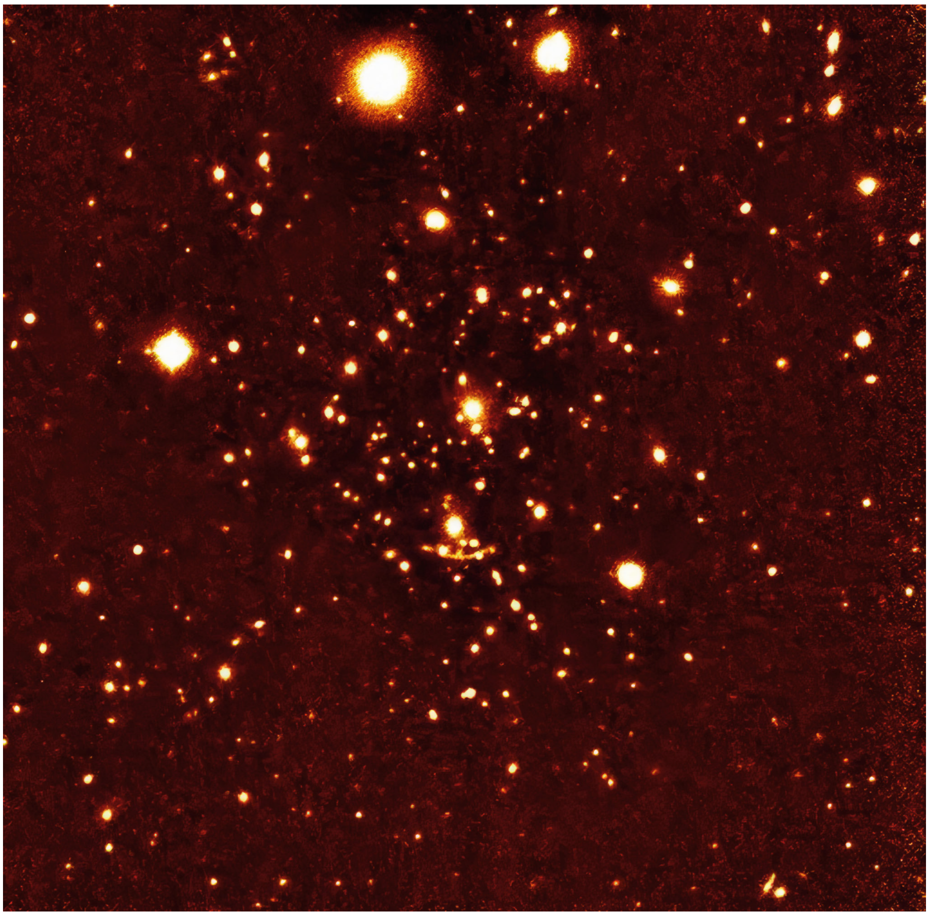

Figure 1. This is a J-band (1.25 micron) image of the galaxy cluster Abell 370 (z = 0.375), obtained in 'jitter' mode, showing the famous gravitational arc just below the centre. The observations consisted of 24 exposures of two minutes each, made on randomly generated telescope positions within a sky region of 30 × 30 arcseconds. The individual exposures have been sky-subtracted using a running average determined from the same data and then re-centred and combined. The scale is 0.29 arcsec pixel^{-1}; the field is about 5 × 5 arcminutes with north at the top and east to the left.

Technical challenges

A cryogenic instrument needs to be warmed up for any technical intervention on the cold components and SOFI was no exception. The warming/cooling cycle needs time to avoid thermal shocks on the components and the same components need to be built using special materials which will work correctly both at room temperature for testing, and at cryogenic temperatures. SOFI had several of these interventions, both to improve its performance and to fix broken parts; special care was taken during the thermal cycles to ensure the integrity of the instrument and a dedicated clean space was set up in the Nasmyth A room to work on the maintenance of the components.

The other interesting challenge was data reduction, in particular to flat-field the data; the shading effect on the detector was found to depend on the flux, which led to the development of special templates for the dome flat-fields, where a set of images were taken with the detector only partially illuminated to allow for an estimate of the shading when the lamp was on with respect to the dark frames. On the data reduction side, Nicolas Devillard played a fundamental role in writing the data reduction algorithm[3] but help was needed from astronomer colleagues to explain the ins and outs of astronomical data reduction and the structure of a FITS header.

Scientific achievements

Being a workhorse instrument, SOFI had a large and varied community of users. Among many scientific highlights were: the combined observations with other instruments of SN1998bw, the first hypernova ever associated with a long-duration gamma-ray burst (Iwamoto et al., 1998); the first large extragalactic surveys in the near-infrared (the K20 survey; Cimatti et al., 2002); and imaging of the famous 'deep fields' in the southern hemisphere, the Chandra deep field (Hatziminaoglou et al., 2002; Moy et al., 2003) and the Hubble deep field (Vanzella et al., 2002). Closer to home, SOFI played an important role in the Araucaria project[4], aimed at improving the calibration of the cosmic distance scale in the local Universe, which led to many seminal papers, and in observations of newborn stars. Even closer to home, SOFI was used to observe sources in the Solar System and even supported space missions (mostly lunar observations).

Beside the vast scientific production, SOFI yielded beautiful images too, which were also featured in NASA's Astronomy Picture of the Day[5].

Concluding remarks

As with any other workhorse instrument, SOFI has served a large fraction of the astronomical community with a variety of scientific programmes, something fundamental for the large number of users ESO has. The intense demand for workhorse instruments continues to the present day, as is evidenced by the large pressure factors on the Ultraviolet and Visual Spectrograph (UVES), the FOcal Reducer and low dispersion Spectrographs 1 and 2 (FORS1, FORS2), X-shooter and the Multi Unit Spectroscopic Explorer (MUSE), some of which are only a few years younger than SOFI.

Many astronomers — Jean-Gabriel Cuby, Malvina Billeres, and the authors of this paper — have served as instrument scientists for SOFI. Some were already familiar with near-infrared instruments, but for others, SOFI was their first taste of observations in the near-infrared. SOFI, on top of its many achievements, was a patient teacher.

Acknowledgements

We wish to thank all the telescope operators who have helped with running SOFI, and all the colleagues from Chile and Garching who have contributed with their work to the smooth operation of the instrument.

References

Cimatti, A. et al. 2002, A&A, 381, L68
Hatziminaoglou, E. et al. 2002, A&A, 384, 81
Iwamoto, K. et al. 1998, Nature, 395, 672
Moorwood, A., Cuby, J.-G. & Lidman, C. 1998, The Messenger, 91, 9
Moy, E. et al. 2003, A&A, 403, 493
Vanzella, E. et al. 2002, A&A, 396, 847

Links

1 SOFI first light: https://www.eso.org/public/news/eso9805/
2 ISAAC overview: https://www.eso.org/sci/facilities/paranal/decommissioned/isaac.html
3 Jitter description: https://www.eso.org/sci/software/eclipse/faq/faq-jitter.html
4 Araucaria project: https://araucaria.camk.edu.pl
5 SOFI APOD: https://apod.nasa.gov/apod/ap000919.html

ESO/A. Ghizzi Panizza (www.albertoghizzipanizza.com)

Standing majestically at the top of a hill at ESO's La Silla Observatory, surveying the watercolour scenery of another sunset in Chile's Atacama Desert, is the New Technology Telescope (NTT). It has been ticking along, making discovery after discovery, ever since it was inaugurated in 1989. Its home at La Silla sits at an altitude of 2400 metres and is far from sources of light pollution, giving the NTT uninterrupted views of the Universe.