

Sophie Beaumont



Title

The Athena/X-IFU instrument, from detector development to scientific feasibility studies

Abstract

The investigation of the physical hot and energetic phenomena in the Universe will further improve our understanding of the assembly of the largest structures and massive halos of galaxies, and of the role of black holes in shaping the Universe as we see it. Spatially resolved X-ray high-resolution spectroscopy will be a crucial tool to achieve these scientific goals. The X-IFU instrument onboard the Athena observatory will provide us with these capabilities through the use of arrays of Transition edge microcalorimeters detectors. These superconducting devices will deliver the required exquisite spectral resolution needed to achieve the core science objectives, such as the characterization of turbulence and bulk motions in the hot gaseous atmospheres of groups and clusters of galaxies in order to unveil the process of large scale structures assembly. I will present the Transition Edge Sensors principle, the status of the instrumental development for the X-IFU instrument, and discuss their performance in view of the scientific objectives of the Athena mission. I will further present the case of a feasibility study and optimisation of the observing strategy for the characterization of the internal dynamics of the intra-cluster medium, through the use of mock simulations of observations with the X-IFU instrument.

EDUCATION AND DIPLOMAS

Ph.D. student

Sept. 2019 – today

X-ray instrumentation and astrophysics.

University Paul Sabatier, Toulouse (France)

- High resolution X-ray spectroscopy with Athena/XIFU: microcalorimeters development & impact of spectroscopy knowledge on astrophysical data analysis
- Research performed in co-direction NASA/GSFC (USA) + IRAP (France)

MSc degree

2016 – 2018

Astronomy, Astrophysics and Space Engineering – Astronomical and space-based systems engineering major, obtained with highest honors.

Observatoire de Paris (France)

- 1st year: fundamental and applied topics in astronomy, astrophysics and instrumentation. 2nd year: practical knowledge needed for the design of complex ground and space-based systems; system analysis; technical expertise in optics, electronics, and programming

Engineer's (eq. MSc) degree

2008 – 2011

Geophysics, obtained with high honors.

EOST (Ecole et Observatoire des Sciences de la Terre), Strasbourg (France)

- In-depth study of geophysical methods, geological environment and mathematical and computing tools used for data processing and interpretation

Bachelor's degree

2008 – 2009

Earth Sciences, obtained with honors.

EOST (Ecole et Observatoire des Sciences de la Terre), Strasbourg (France)

- Prepared in parallel with 1st year of engineering school

CPGE

2006 – 2008

Classe Préparatoire aux Grandes Ecoles – Physics major.

High school Paul Cézanne, Aix-en-Provence (France)

- Two-year class preparing for national entrance exams leading to French "Grandes Ecoles". Specialized in physics, mathematics and chemistry

Baccalauréat

2006

French HS diploma – Sciences major, obtained with high honors.

High school Ismaël Dauphin, Cavaillon (France)

WORK EXPERIENCE

Faculty research assistant

Apr. 2018 – Today

UMBC, based at GSFC/NASA, Microcalorimeter group. Washington DC area (USA)

- TES microcalorimeter detector characterisation, test and optimization for future X-ray missions, including the Athena mission and its X-IFU instrument
- Collaboration started with IRAP to test these detectors in the complete detection chain currently being developed there for the X-IFU instrument

Technical trainee

May – June 2017

ISAS/JAXA, Department of Space Astronomy & Astrophysics. Tokyo area (Japan)

- Comparison of the two most commonly used atomic line emission databases in the soft X-ray waveband. Assessed the differences between these codes and how well they reproduce the highest spectral resolution data available

Imaging specialist

June – Aug. 2016

PGS, Imaging department. Oslo (Norway)

- Test new or specific data processing methods, as proof of concept for full projects or for research and development

Project Geophysicist

Oct. 2013 – May 2016

PGS, Imaging department. Oslo (Norway) / Weybridge (UK)

- Project leader on seismic data processing, with a team of up to 5 persons. Performed or delegated and supervised testing, production and quality control tasks. Client communication. Project management

Geophysicist

Oct. 2011 – Sept. 2013

Trainee

Feb. – Aug. 2011

Intern

July – Aug. 2010

Intern

Aug. 2009

Activity organizer

Summer 2006 and 2007

PGS, Imaging department. Oslo (Norway)

- Processing of seismic projects (including testing, production, and quality control)

PGS, Geoscience and Engineering group. Oslo (Norway)

- Master thesis internship in R&D, testing a new method for the analysis of data acquired with several azimuths

University College London, Department of Earth and Planetary Sciences. London (UK)

- Geochemical and mineralogical study of lunar samples (Apollo 12 mission)

Keele University, Applied & Environmental Geophysics Research Group. Keele (UK)

- Acquisition and processing of data gathered using various methods (ERT, radar gravimetry)

Astronomy center of St-Michel-l'Observatoire. Saint-Michel-l'Observatoire (France)

- Leading of astronomy related activities (talks, demonstrations using telescopes), for all types of public

COMPETENCES

Languages

| | |
|-----------|-----------------|
| French | mother tongue |
| English | fluent |
| Norwegian | basic knowledge |
| Spanish | basic reading |

Computer skills

Operating systems: Windows, Linux, Mac OS

Software: Microsoft office (Word, Excel, PPT, Project, Outlook), LaTeX, Gimp

Programming: Python, Shell, C, Fortran 90, IDL

Technical software: SPEX, XSPEC, Comsol, SolidWorks

PUBLICATIONS AND CONFERENCES

--- *Space Instrumentation* ---

"*Extension of the energy range accessible with a TES using bath temperature variations*"

Beaumont S., Adams J. S., Bandler S., Chervenak J., Finkbeiner F. M., Hummatov R., Kelley R. L., Kilbourne C. A., Miniussi A. R., Porter F. S., Sadleir J. E., Sakai K., Smith S. J., Wakeham N. A., Wassell E. J., *Journal of Low Temperature Physics*, 199 704-715 (2020), DOI: [10.1007/s10909-020-02400-x](https://doi.org/10.1007/s10909-020-02400-x)

"*Data analysis and results for multi-absorbers TES*"

Beaumont S., Adams J. S., Bandler S., Chervenak J. A., Datesman A. M., Finkbeiner F. M., Hummatov R., Kelley R. L., Kilbourne C. A., Miniussi A. R., Porter F. S., Sadleir J. E., Sakai K., Smith S. J., Wakeham N. A., Wassell E. J., Witthoef M. C., *18th International Workshop on Low Temperature Detectors (LTD-18)*, Poster presentation

"*Performance of a broad-band, high-resolution, transition-edge-sensor spectrometer for laboratory and space x-ray astrophysics experiments*"

Smith S. J., Adams J. S., Bandler S., **Beaumont S.**, Chervenak J. A., Denison E. V., Doriese W. B., Durkin M., Finkbeiner F. M., Fowler J. W., Hilton G. C., Hummatov R., Irwin K. D., Kelley R. L., Kilbourne C. A., Leutenegger M. A., Miniussi A. R., Porter F. S., Reintsema C.D., Sadleir J. E., Sakai K., Swetz D. S., Ullom J. N., Vale L. R., Wakeham N. A., Wassell E. J., Witthoef M. C., *IEEE Transactions on Applied Superconductivity*, (2021), DOI: [10.1109/TASC.2021.3061918](https://doi.org/10.1109/TASC.2021.3061918)

"*A test platform for the detection and readout chain for the Athena X-IFU*"

Betancourt-Martinez G., **Beaumont S.**, Bertrand B., Cucchetti E., Dupieux M., Herve G., Pajot F., Peille P., Ravera L., Roudil G., Wernicke D., *Conference Space Telescopes and Instrumentation 2020: Ultraviolet to Gamma Ray, part of SPIE Astronomical Telescopes + Instrumentation*, Paper in preparation

"*Quantum efficiency study and reflectivity enhancement of Au/Bi absorbers*"

Hummatov R., Adams J. S., Bandler S., Barlis A., **Beaumont S.**, Chang M. P., Chervenak J. A., Datesman A. M., Eckart M. E., Finkbeiner F. M., Ha J. Y., Kelley R. L., Kilbourne C. A., Miniussi A. R., Porter F. S., Sadleir J. E., Sakai K., Smith S. J., Wakeham N. A., Wassell E. J., Wollack E. J., *Journal of Low Temperature Physics*, 199 393-400 (2020), DOI: [10.1007/s10909-020-02424-3](https://doi.org/10.1007/s10909-020-02424-3)

"Thermal crosstalk measurements and simulations for an X-ray microcalorimeter array"

Miniussi A. R., Adams J. S., Bandler S., **Beaumont S.**, Chang M. P., Chervenak J. A., Finkbeiner F. M., Ha J. Y., Hummatov R., Kelley R. L., Kilbourne C. A., Porter F. S, Sadleir J. E., Sakai K., Smith S. J., Wakeham N. A., Wassell E. J., *Journal of Low Temperature Physics*, 199 663-671 (2020), DOI: [10.1007/s10909-019-02312-5](https://doi.org/10.1007/s10909-019-02312-5)

"Thermal impact of cosmic ray interaction with an X-ray microcalorimeter array"

Miniussi A. R., Adams J. S., Bandler S., **Beaumont S.**, Chang M. P., Chervenak J. A., Finkbeiner F. M., Ha J. Y., Hummatov R., Kelley R. L., Kilbourne C. A., Porter F. S, Sadleir J. E., Sakai K., Smith S. J., Wakeham N. A., Wassell E. J., *Journal of Low Temperature Physics*, 199 45-55 (2020), DOI: [10.1007/s10909-020-02337-1](https://doi.org/10.1007/s10909-020-02337-1)

"Demonstration of Fine-Pitch High Resolution X-ray TES Microcalorimeters Optimized for Energies below 1 keV"

Sakai K., Adams J. S., Bandler S., **Beaumont S.**, Chervenak J. A., Eckart M. E., Finkbeiner F. M., Hummatov R., Jaeckel F., Kelley R. L., Kilbourne C. A., McCammon D., Miniussi A. R., Porter F. S, Ryu K., Sadleir J. E., Smith S. J., Wakeham N. A., Wassell E. J., *Journal of Low Temperature Physics*, 199 949-954 (2020), DOI: [10.1007/s10909-020-02409-2](https://doi.org/10.1007/s10909-020-02409-2)

"Towards 100,000-pixel microcalorimeter arrays using multi-absorber transition-edge sensors"

Smith S. J., Adams J. S., Bandler S., **Beaumont S.**, Chervenak J. A., Datesman A. M., Finkbeiner F. M., Hummatov R., Kelley R. L., Kilbourne C. A., Miniussi A. R., Porter F. S, Sadleir J. E., Sakai K., Wakeham N. A., Wassell E. J., Witthoef M. C., Ryu K., *Journal of Low Temperature Physics*, 199 330-338 (2020), DOI: [10.1007/s10909-020-02362-0](https://doi.org/10.1007/s10909-020-02362-0)

"High-frequency noise peaks in Mo/Au superconducting transition-edge sensor microcalorimeters"

Wakeham N. A., Adams J. S., Bandler S., **Beaumont S.**, Chang M. P., Chervenak J. A., Datesman A. M., Eckart M. E., Finkbeiner F. M., Ha J. Y., Hummatov R., Kelley R. L., Kilbourne C. A., Miniussi A. R., Porter F. S, Sadleir J. E., Sakai K., Smith S. J., Wassell E. J., *Journal of Low Temperature Physics*, 199 192-199 (2020), DOI: [10.1007/s10909-019-02322-3](https://doi.org/10.1007/s10909-019-02322-3)

"Thermal fluctuation noise in Mo/Au superconducting transition-edge sensor microcalorimeters"

Wakeham N. A., Adams J. S., Bandler S., **Beaumont S.**, Chervenak J. A., Datesman A. M., Eckart M. E., Finkbeiner F. M., Hummatov R., Kelley R. L., Kilbourne C. A., Miniussi A. R., Porter F. S, Sadleir J. E., Sakai K., Smith S. J., Wassell E. J., *Journal of Applied Physics* 125, 164503 (2019), DOI: [10.1063/1.5086045](https://doi.org/10.1063/1.5086045)

"Extended line spread function of TES microcalorimeters with Au/Bi absorbers"

Eckart M. E., Adams J. S., Bandler S., **Beaumont S.**, Chervenak J. A., Datesman A. M., Finkbeiner F. M., Hummatov R., Kelley R. L., Kilbourne C. A., Leutenegger M. A., Miniussi A. R., Moseley S. J., Porter F. S, Sadleir J. E., Sakai K., Smith S. J., Wakeham N. A., Wassell E., *IEEE Transactions on Applied Superconductivity*, Vol 29 No 5 (2019), DOI: [10.1109/TASC.2019.2903420](https://doi.org/10.1109/TASC.2019.2903420)

--- Geophysics ---

"Dual-sensor data and enhanced depth imaging sheds new light onto the mature Viking Graben area"

Ciotoli M., **Beaumont S.**, Oukili J., Korsmo Ø., O'Dowd N., Rønholt G., Dirks V., *First Break*, Vol 34 No 9, pp. 73-79 (2016), DOI: n/a - [link](#)

"Multi-azimuth Prestack Time Migration for General Anisotropic, Weakly Heterogeneous Media - Field Data Examples"

Beaumont S., Söllner W., *75th EAGE Conference & Exhibition* (2013), Poster presentation + Extended abstract published, DOI: [10.3997/2214-4609.20130950](https://doi.org/10.3997/2214-4609.20130950)

INTERESTS

- Jogging few times a weeks; horse riding, cross-country skiing and hiking whenever possible
- Astronomy (reading of specialized magazines, observations on telescopes)
- Self-learning acrylic painting for the past two years