SRON Overview and Outlook

Michael Wise
General and Scientific Director

57th ESSC Plenary Meeting
May 9, 2019

SRON Mission Statement

“To enable breakthroughs in research from space by the definition, development, and scientific use of world-class instrumentation.”
Collaborations and New Locations

- One Institute, two locations, ~190 staff (~140 Leiden, ~50 Groningen)
- Strong scientific and technical connections in both locations
- Six new staff positions to support collaboration with Leiden/TU Delft
- Process already underway to identify candidates and fill positions

Role of the Institute

- Home base for NL instrumentation in the ESA science program
- National expertise institute for scientific space research
- Performs scientific research in astrophysics, Earth science, exoplanets, and new technology
- Develop pioneering technology for advanced space instruments
- Design and build instruments for scientific space research
- Advice to government on behalf of the space research community
- Provide community support for the scientific exploitation of space instruments and missions
- Promotes societal applications of space including valorization
SRON Research Themes

- **Astrophysics**
  - High-energy astrophysics (the hot evolving Universe, properties and evolution of black holes, neutron stars, etc.)
  - Low-energy astrophysics (the cool obscured Universe, birth of stars, planets, evolution of stars and galaxies, etc.)

- **Earth science**
  - Atmospheric composition and chemistry (ozone, methane, CO2, aerosols, etc.)

- **Exoplanets**
  - Atmospheres of exoplanets (ultimately Earth-like exoplanets)

- **Technology development**
  - New technology for space instrumentation enabling future discoveries, ground-based, and balloon-borne demonstrators
Sentinel-5P/TROPOMI results: CH₄ mapping

March 2019 release

Hu et al., 2018, Lorente et al., 2019

Athena XIFU Detector Performance

SRON TES calorimeter performance close to XIFU requirements
Comparable to performance of world leading NASA-GSFC detectors
Current SRON ESA Mission Roadmap

1. Realized/approved hardware instrument contributions (from idea to launch)
   - RGS R&D to XMM launch: ESA Cornerstone
   - LETG R&D to Chandra launch: NASA Great Observatory
   - SIS R&D to HIFI/Herschel launch: ESA Cornerstone
   - Sciamachy/ENVISAT: ESA EO programme
   - TES/FM R&D to X-IFU/Athena launch: ESA L2
   - Spect. R&D to TROPOMI: EU EO programme Sentinel-5P
   - IG R&D to Sentinel programme: XRSIM
   - Hitomi: JAXA
   - PLATO: ESA M3

2. Current non-space applications and demonstrators
   - SIS/HEB R&D: ALMA, STO-2, GUSTO
   - KID R&D: AMKID (KID R&D)
   - IG R&D: Metis E-ELT
   - SPEX Airborne (aerosol)

3. Involvement in future instrument contributions (from idea to launch)
   - TES/FDM R&D to SPICA/SAFARI launch: ESA M5
   - KID R&D to space instrument: SPEX R&D to space instrument!
   - ARIEL: ESA M4
   - LISA: ESA L3
   - Characterization Earth-like exoplanets: Development of role for small satellites

Current Project Portfolio

<table>
<thead>
<tr>
<th>Mission/instrument</th>
<th>Programme SRON</th>
<th>Launch date</th>
<th>Agency</th>
<th>Contribution SRON</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sentinel-5P/TROPOMI</td>
<td>Earth</td>
<td>2017</td>
<td>ESA (approved)</td>
<td>co-leading</td>
</tr>
<tr>
<td>Sentinel-5</td>
<td>Earth</td>
<td>2022</td>
<td>ESA (approved)</td>
<td>intermediate</td>
</tr>
<tr>
<td>XRSIM</td>
<td>Astrophysics</td>
<td>2021</td>
<td>JAXA/ESA</td>
<td>small</td>
</tr>
<tr>
<td>PACE/SPExOne</td>
<td>Earth</td>
<td>2022</td>
<td>NASA (approved)</td>
<td>leading</td>
</tr>
<tr>
<td>PLATO</td>
<td>Exoplanets</td>
<td>2026</td>
<td>ESA (M3, adopted)</td>
<td>small</td>
</tr>
<tr>
<td>ARIEL</td>
<td>Exoplanets</td>
<td>2028</td>
<td>ESA/M4 (selected)</td>
<td>small</td>
</tr>
<tr>
<td>Athena/XIFU</td>
<td>Astrophysics</td>
<td>2031</td>
<td>ESA (L2, selected)</td>
<td>co-leading</td>
</tr>
<tr>
<td>SPICA/SAFARI</td>
<td>Astrophysics</td>
<td>2031</td>
<td>ESA/JAXA (M5, candidate)</td>
<td>(co-)leading</td>
</tr>
<tr>
<td>LISA</td>
<td>Astrophysics</td>
<td>2034</td>
<td>ESA (L3, selected)</td>
<td>intermediate</td>
</tr>
<tr>
<td>Demonstrators</td>
<td>All</td>
<td>–</td>
<td>Ground, aircraft, balloon</td>
<td>(co-)leading</td>
</tr>
<tr>
<td>CO2M/SPEX5</td>
<td>Earth</td>
<td>2025</td>
<td>ESA/EC (in competition)</td>
<td>co-leading</td>
</tr>
</tbody>
</table>

Additional opportunities: eXTP (X-ray timing), HUBS (X-ray imaging surveys), NCLE followup mission, small satellite platform, etc.
XRISM - X-Ray Imaging Spectroscopy Mission

High spectral resolution calorimeter and moderate spatial resolution

Followup to failed Hitomi mission (Feb 2016)

Joint JAXA, ESA, NASA mission

SRON providing filter wheel assembly and onboard X-ray calibration source

Planned launch in 2021

(Nature, Fabian et al. 2016)

ATHENA
THE ASTROPHYSICS OF THE HOT AND ENERGETIC UNIVERSE

Europe’s next generation X-RAY OBSERVATORY

• Athena selected as L2 mission in ESA Science program (~1B€)
• Evolution of large-scale structure, growth of BHs, chemical enrichment, stars, exoplanets, pulsars, neutron stars, gamma ray bursts, GW followup, etc.
• SRON is co-PI of calorimeter instrument (X-IFU: spectroscopic X-ray camera)
• Supported by NWO Roadmap funding ~20 M€ (PI. J.W. den Herder)

• Successful recent Athena IPRR for XIFU and WFI, instruments now in phase B1
• Currently highest priority for the Astrophysics programme line
SPExOne – Spectro-Polarimeter for Planetary Exploration

- Synergetic payload for aerosol, cloud, and ocean science on NASA PACE mission
- Successful SPExOne Critical Design Review CDR (NASA, NSO, SRON, TNO, Leiden) - clearance to start manufacturing phase
- Supported by 7 M€ subsidy from NSO

SPICA – Unveiling the Cold Obscured Universe

- SPICA - a large cryogenically cooled infrared telescope
- Evolution of galaxies in the early universe, planet formation, star formation, etc.
- ESA-JAXA collaboration with partners in Europe, Canada, US and Taiwan, M5 mission candidate (decision in ~2021)
- SRON is PI of SAFARI spectrograph
- Currently refining requirements and design to prepare for selection
- Still need to secure commitments for national funding from all partners
LISA – Gravitational Wave Astronomy in Space

- LISA - Laser Interferometer Space Antenna
- L3 mission candidate in ESA program (launch in ~2034)
- SRON investigating potential hardware contributions (with TNO, Nikhef)
- NSO subsidy of 1 M€ pending for TNO feasibility study

- Strong NL science community, clear route to SRON flight hardware
- Total cost likely to be large, but not currently on NL large-scale infrastructure roadmap

eXTP – enhanced X-ray Timing and Polarimetry

- Proposed ESA Mission of Opportunity with China with launch ~2025
- Simultaneous, high-throughput spectral, timing and polarimetry observations
- Strong European consortium, including significant NL community (UvA, RUG)
- Participation options - minimum (software), medium (hardware design), large (flight hardware)
NextSpec – Next Generation X-ray Analysis Software

- Modern software suite designed to support new X-ray spectral, spatial, and timing data
- Builds upon SPEX software and SRON expertise in high resolution X-ray spectral analysis
- Collaboration with UvA, Leiden, RUG, and SRON (basic NL contribution to eXTP)
- Specifically targeted at advanced analysis of XRSIM, eXTP, and Athena data

Small Satellite Science Platform

Supports wide range of science cases (Earth, Planetary exploration, Exoplanets, Radio Astronomy, Space weather)

Low cost (<5 M€), fast development (3-5 yrs)

Broad NL research and industrial involvement

Community workshop planned for Oct 2019
Technology Research Program

The Technology research program supports SRON’s strategic long-term plans, driven by the science goals of the Astro, Earth and Exo program lines. Activities usually are at low technology readiness levels (TRL ≤ 5)

- Cryogenic sensors (direct detector arrays and heterodyne)
- Read-out electronics
- Ultra-high contrast imaging and optics
- Focal plane assembly
- Instrument concepts and demonstrators to raise TRLs

Near term Priorities

- **Astrophysics**
  - Prepare for science with XRISM
  - Focus on Athena XIFU development and schedule
  - Prepare for SPICA/SAFARI mission selection in 2021
  - Explore NL participation in LISA and eXTP

- **Earth science**
  - Focus on construction phase of SPEXone instrument
  - Prepare for phase B of MAP instrument on ESA/EC CO2M/Sentinel-7

- **Exoplanets**
  - Maintain science and calibration roles in ARIEL and PLATO
  - Explore options for an expanded hardware role in PLATO

- **Technology development**
  - Advance current technologies in TES/FDM, KID/mu-wave
  - Initiate optics development line in collaboration with TUD/Leiden
Thanks for your attention!

https://www.sron.nl
https://twitter.com/SRON_Space