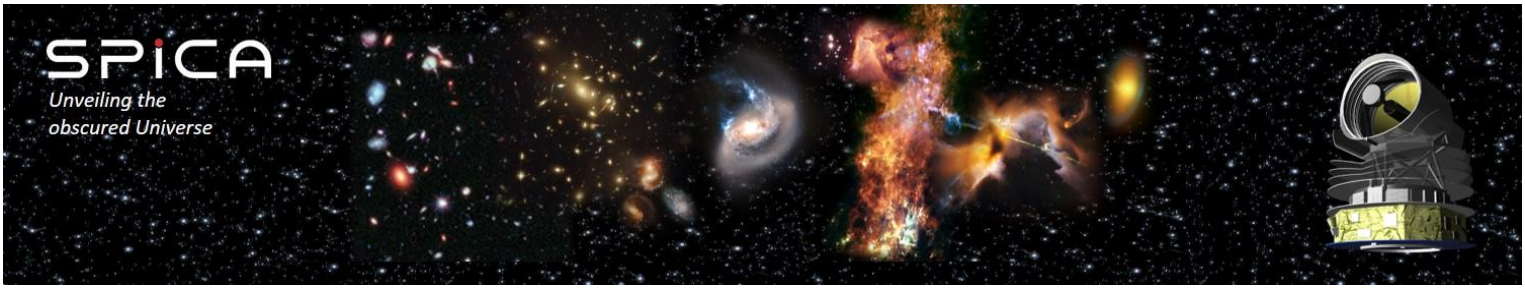

SPICA candidate for ESA's next medium-class science mission

The infrared space telescope SPICA has been selected from about 25 mission proposals to be further developed and studied in full detail by the European Space Agency. Under SRON leadership, in close collaboration with the Japanese Space Agency JAXA, the SPICA proposal had been submitted to ESA as a candidate for the 'Cosmic Vision M5' programme. The selection of SPICA is a crucial step towards solving a number of fundamental questions in modern astronomy – with SPICA the growth and evolution of galaxies from over cosmic time can be fully characterised, in addition and also it will allow us to better understand the conditions that promote the formation of planetary systems like our own.

The universe unveiled

SPICA has been designed to be extremely sensitive to infrared radiation. Unlike visible light, infrared radiation is not absorbed by the dust that pervades the universe – as a result, observations in the infrared literally unveil the hidden universe, allowing us to see deep into the inner reaches of galaxies, star forming clouds and planet forming systems.

One of the big questions in astronomy is which processes regulate the formation and evolution of galaxies. Early in the history of the Universe, about twelve billion years ago, the first stars and galaxies started forming. In the next few billion years the process of formation and evolution sped up, becoming increasingly more efficient until that activity peaked about nine billion years ago, and since then the production of these megastructures has been slowing down continuously. The cause for the increase, peak and subsequent decrease of galaxy formation efficiency is still the subject of speculation. With SPICA spectral 'fingerprints' will be taken for many thousands of galaxies spread over cosmic time. With these fingerprints we will be able to accurately probe the physical conditions in and around these galaxies, and thus determine which are the factors that govern the formation and evolution of galaxies.

In the nearby universe SPICA will provide detailed insight into the formation processes of stars and planetary systems. These occur deep inside dense dusty clouds of matter and can only be studied in the infrared. Equally, observations of the infrared spectral fingerprints of ions, atoms, molecules, dust grains and ices allow astronomers to probe not only the physical conditions in and around planet forming disks, but also to establish where in the planet forming disk molecules like water are solid or gaseous, and thus will chart the 'snowline'. By combining these results with observations of dust

rings around full-grown planetary systems the link can be made to the solar system and its dust ring, the so-called 'Oort cloud'; in this way SPICA will yield valuable clues to the formation of our own planetary system.

The SPICA observatory

The promise of SPICA is made possible by the combination of a number of significant innovations. A key component is the use of a large 2.5 meter diameter telescope that is cooled to almost 270 degrees below zero, to reduce the background radiation emitted by the telescope itself to the absolute minimum. With such a low background the extremely sensitive Transition Edge Sensors (TES), developed both in the Netherlands at SRON as well as in partner institutes in the UK and the US, can be used to their full potential. The combination of the cold telescope and the ultrasensitive detectors will make SPICA the most sensitive observatory in the mid- and far infrared ever – with this extreme sensitivity the SPICA instruments will be able to take the spectral fingerprints of objects out to the farthest reaches of the universe.

The observatory will have three instruments covering the full mid- and far-infrared, the wavelength domain between 12 and 350 micrometres. A combined mid-infrared camera and spectrometer will be provided by a large Japanese consortium led by the University of Nagoya, a French-led European consortium will build a compact imaging polarimeter, and a large SRON-led international consortium will design and implement the largest and most complex instrument, the far-infrared spectrometer SAFARI,

SPICA will be used by the world-wide astronomical community. As is the custom for other great ground based and space observatories all astronomers can propose observations. A panel of independent specialists will rate the proposals according to their scientific quality and determine if and how much time will be awarded for the observations. Proposers will have about a year proprietary access to the measurement, after that period the data are made public to be used by anyone that is interested.

The SAFARI instrument

SAFARI is the far-infrared spectrometer for the SPICA observatory. It covers the wavelength range from 34 to 230 micrometres with over 3000 Transition Edge Sensors (TES). The telescope focusses the radiation onto the instrument where it is dispersed into its different component colours using a diffraction grating, thus each detector 'sees' a slightly different colour. To obtain more spectral detail a so-called Martin-Puplett interferometer can be inserted into the light path. To achieve the ultimate sensitivity the TES detectors must be cooled to 50 millidegrees above absolute zero; SAFARI has a dedicated cooler to achieve this goal. The many years of TES development, with leading roles for SRON as well as other SAFARI consortium institutes, has resulted in extremely sensitive detectors. Coupled with the large and cold SPICA telescope these detectors will allow SAFARI to observe sources two orders of magnitude weaker than previously possible.

SRON leads the international consortium that has formed to build the SAFARI instrument. Almost 20 institutes from 15 countries from around the globe participate in the project. Every institute brings its own expertise and experience; SRON brings it system overview and together with the US and UK TES experience, France provides the milli-degree cooler, Spain the optics and instrument structure and Canada the Martin-Puplett interferometer. Smaller contributions are provided by Austria, Belgium, Denmark, Germany, Ireland, Italy, Japan, Sweden, Switzerland and Taiwan.

The SPICA project

SPICA is foreseen as a cooperation between the European and Japanese space agencies ESA and JAXA. ESA, as leader of the project, will take overall responsibility, provide the telescope and the spacecraft support systems, and lead the integration and test of all subsystems in the satellite. Japan will provide the cooling system and takes the responsibility for the integration of the 'payload'; the platform with the telescope and the scientific instruments. In addition, Japan will provide the H3 rocket that will launch SPICA into space. The three instruments are provided by consortia of scientific and research institutes from around the globe.

The SPICA proposal was submitted to ESA in 2016 by a large international consortium under SRON leadership, with partners from Europe, North America and Asia, as a response to the fifth call medium scale mission proposals for ESA's 'Cosmic Vision' programme (Cosmic Vision M5). Along with the SPICA 25 mission proposals were submitted by different European-led consortia, for the 550 million Euro M5 budget. Of these 25 only SPICA and two other proposals have been selected for the last round, in which three parallel detailed studies will be undertaken to establish which mission provides the best balance between scientific results and technical feasibility. It is expected that in 2021 the final decision will be taken as to which of these three projects will be implemented as ESA's M5 mission for launch at the end of the next decade.

Image – option 1; the SPICA satellite

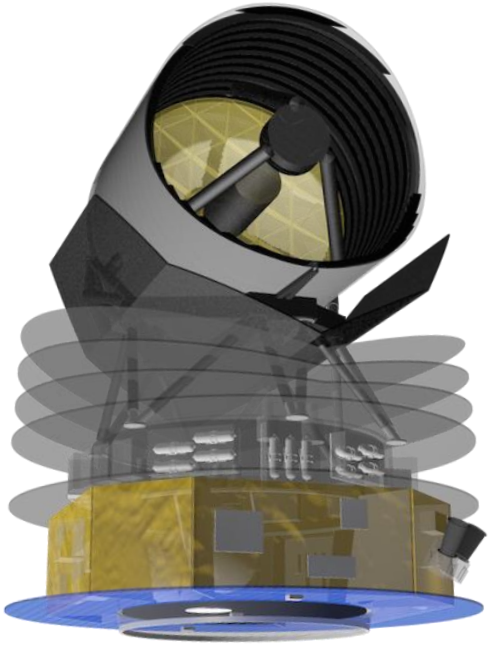

Image – option 2; the SPICA satellite with some explanatory text