Space weather study and high-resolution observations of the Sun with ARKA small explorer

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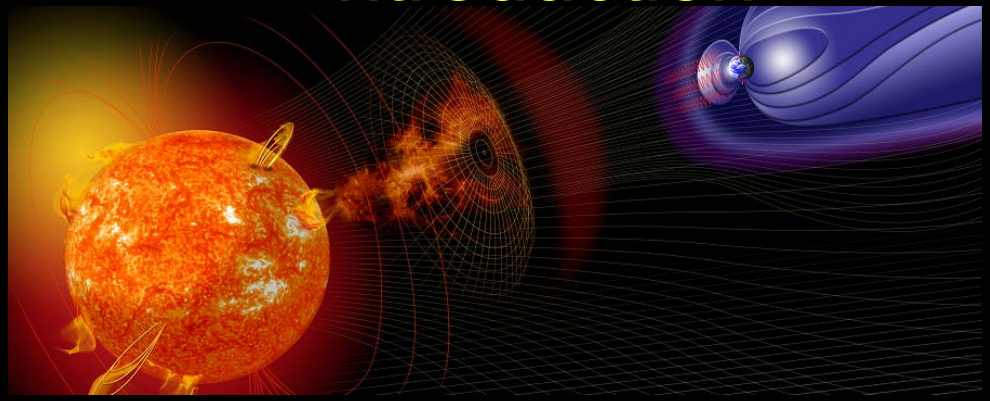
Introduction



Observations of the Sun are the most reliable way to forecast the space weather. This method allows to predict the changes in the radiation state of the near-earth orbital space from several hours to 1-2 days in advance. The disturbances of the Earth's magnetic field can be predicted from 2-3 days to a month ahead.

The best (and sometimes *the only*) way to observe the Sun and its active phenomena (which are the main causes of space weather changes) are space observations with spacecraft.

Federal space program of the Russian Federation

Federal space program of the Russian Federation for 2016-2025 includes 2 space mission to investigate the Sun and solar activity:

1) **SC «Interhelioprobe»** to observe the Sun and solar phenomena from the heliocentric orbit with the perihelion of 60 solar radii.

2) **SC «ARKA»** to provide high-precision solar telescopic observations from a near-earth orbit.

SC «Interhelioprobe» is designed to solve fundamental scientific problems of solar physics. Concerning the space weather, the main task of the mission is to study the space weather fundamental reasons and mechanisms.

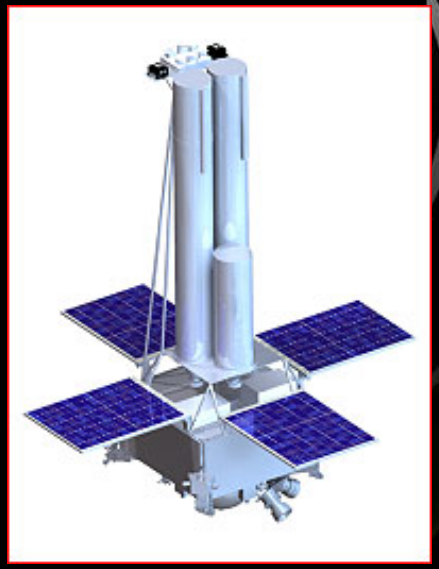
SC «ARKA» will provide continuous observations of the Sun and solar activity with the aim to solve both the fundamental problems and applied tasks of solar physics including the forecast of space weather.

ARKA spacecraft

ARKA is the first Russian small explorer for investigations of the Sun.

The spacecraft will carry 3 scientific instruments (telescopes and a coronagraph) to provide high quality imaging of the Sun.

The total weight of the scientific equipment is about of 100 kg.



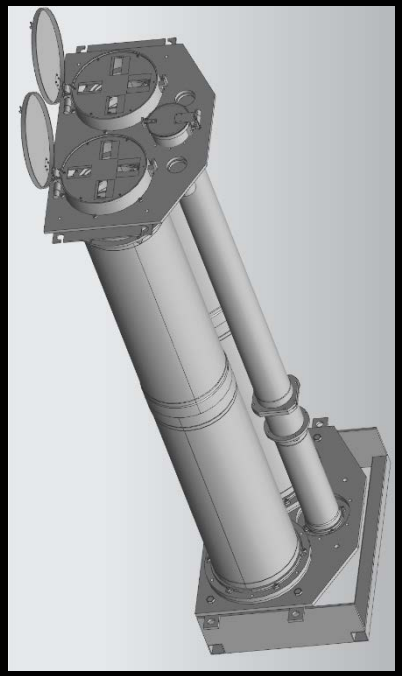
The similar space program of NASA – SMEX (Small Explorers) operates from 1989.

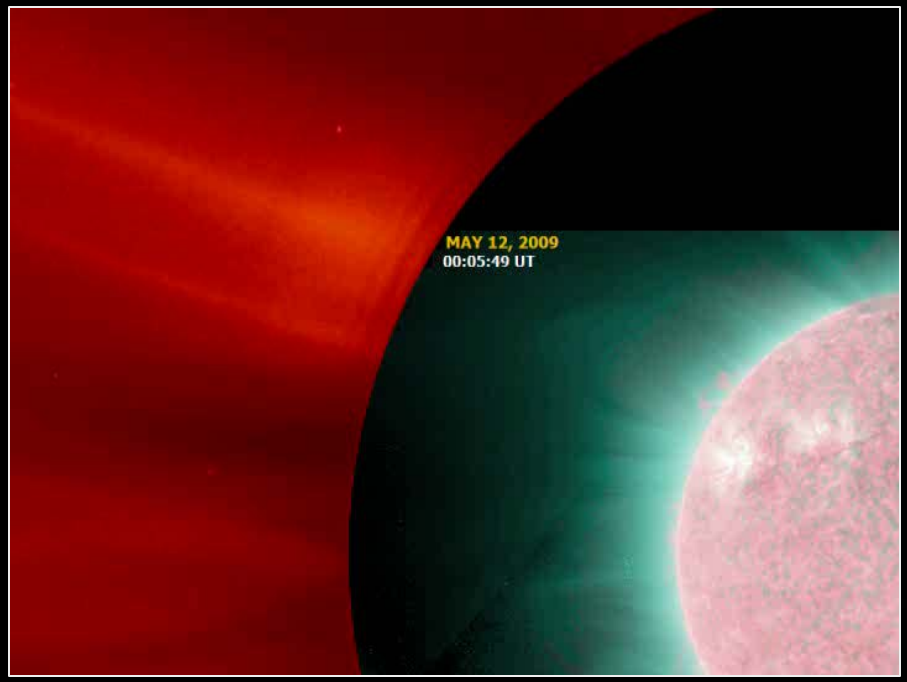
The Russian program of small explorers started about 10 years ago. To the moment, 2 small spacecrafts were launched – «Zond-PP» (2012) and «Relek» (2014).

The «ARKA» mission is going to be the third small Russian explorer (and the first one designed to observe the Sun).

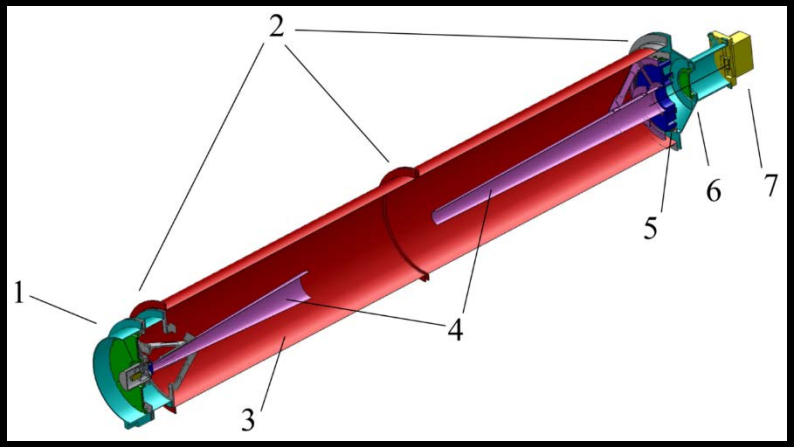
ARKA scientific equipment «Арка»

The ARKA scientific equipment includes 3 instruments – 2 solar telescopes with very high spatial resolution and a white-light coronagraph to observe the solar mass ejections. Such an instrument assembly will allow to observe in detail both the processes near the sun's surface and in the outer layers of solar atmosphere as the enclosed movie demonstrates.

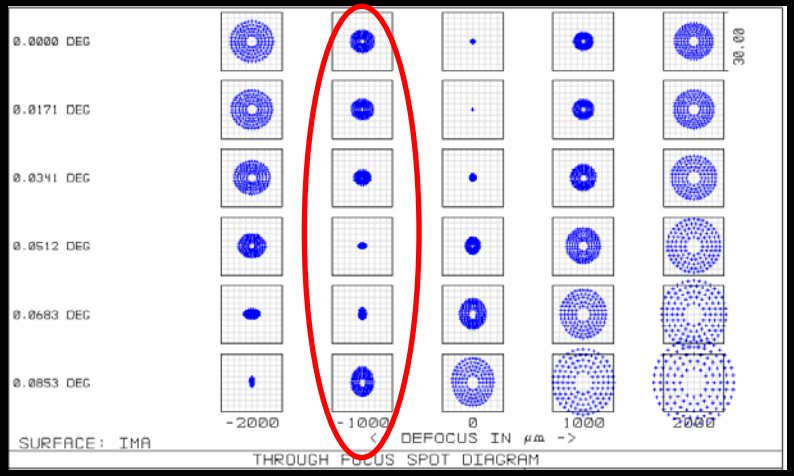




ARKA telescopes principles



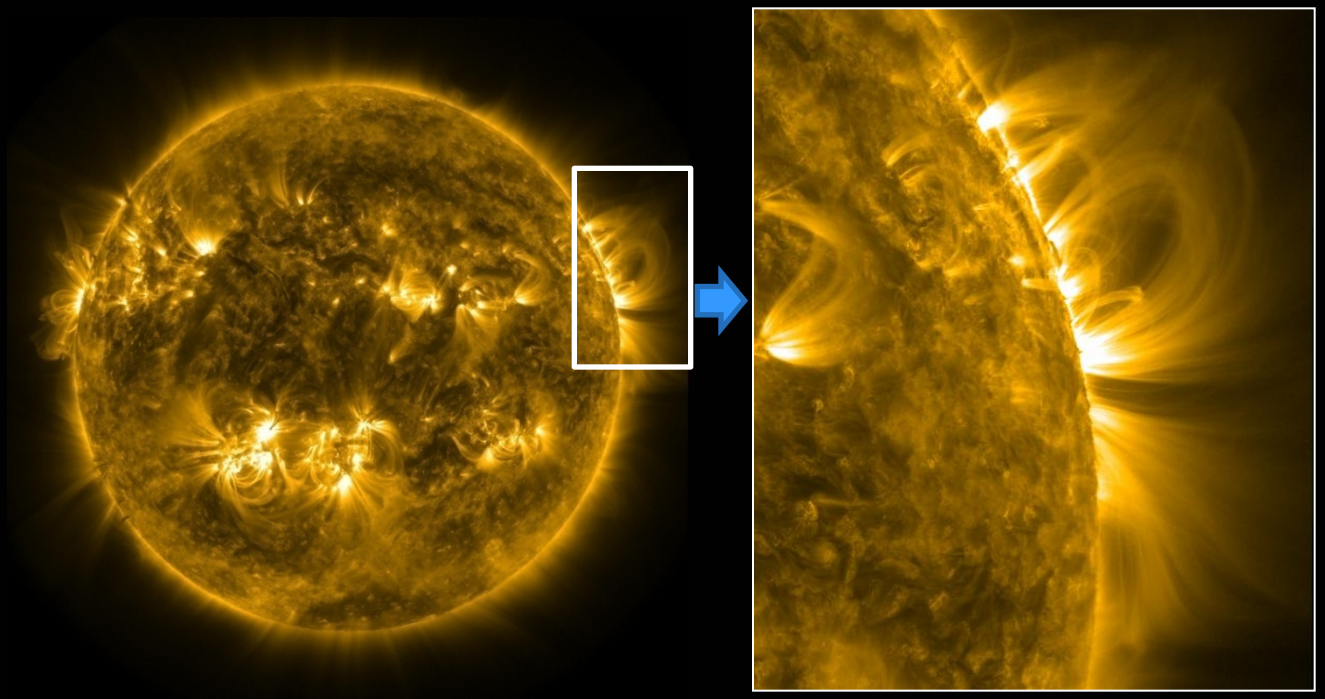
ARKA telescopes are based on the Ritchey-Chretien optical scheme with two aspherical mirrors. The field of view is 10’ by 10’. The telescopes operate in the spectral ranges 171 A (telescope 1) и 304 A (telescope 2).



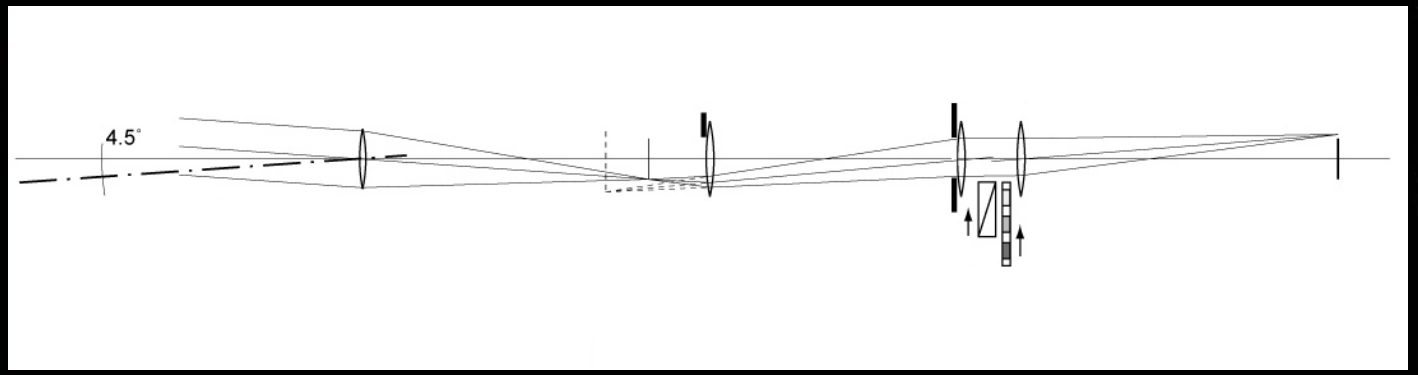
The theoretical estimates show that the angular resolution of the telescopes will be 0.1 arcsec per pixel, which is 6 times more than the angular resolution of the current SDO solar observatory of NASA and 10 times more than the resolution of the previous Russian solar observatory KORONAS-Photon (2009).

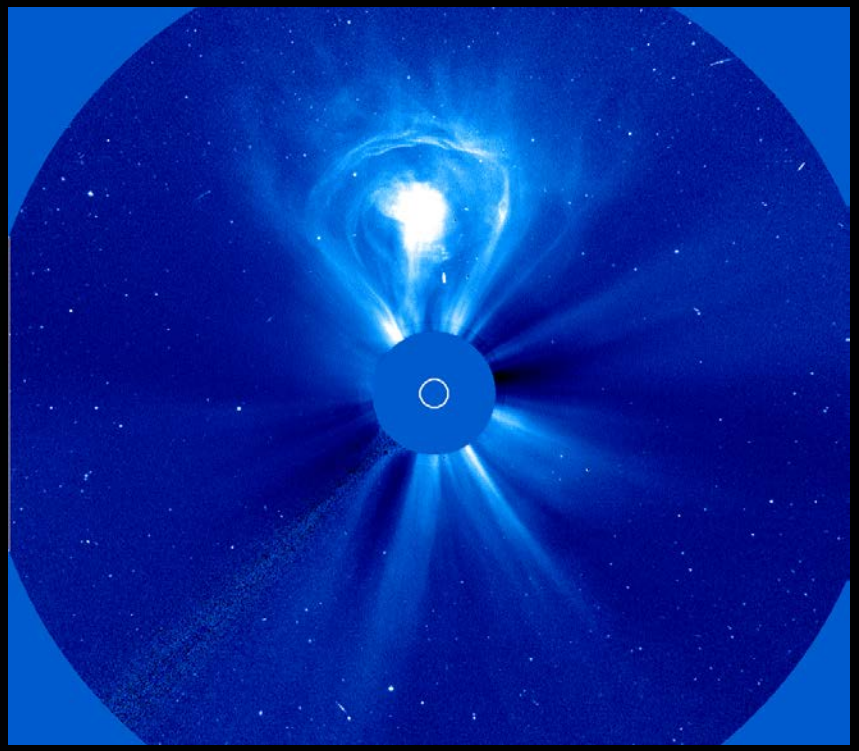
ARKA telescopes

Two ARKA telescopes will provide the imaging of the solar corona and sun's transition level with a precision of 70 km per pixel – the most ever reached during the space solar experiments. Such an accuracy will be achieved thanks to the special mode of observations: the telescopes will observe the Sun within the limited field of view but with a strong magnification within this field.



ARKA coronagraph principles





The third ARKA instrument is a white-light Lyot coronagraph with a field of view of 8 degrees. The main scientific target of the instrument are solar eruptive prominences and coronal mass ejections – the main factors responsible for space weather changes.

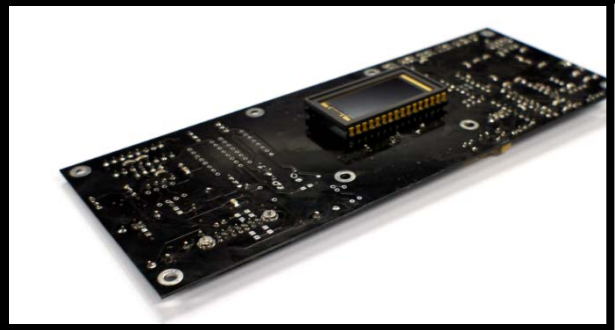
Equipment

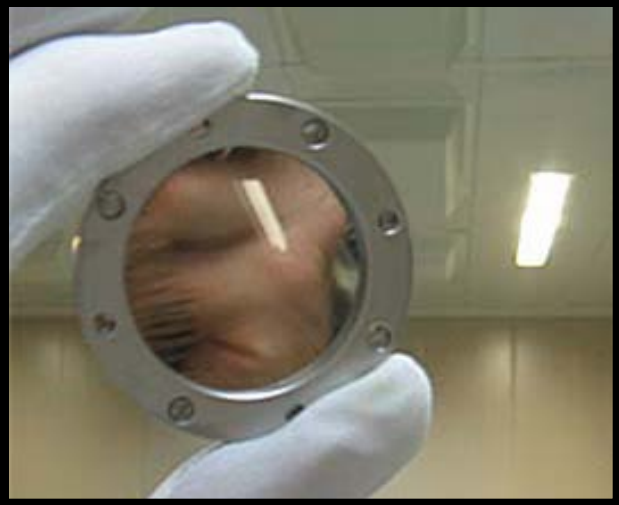
The main construction and optical elements of the ARKA are domestic (made in Russia).

The thermostable construction – INOR (Korolev, Russia).

The x-ray optics (mirrors, lenses and filters) – IPM RAS (Nizhny Novgorod, Russia).

Electronics and interfaces – LPI (Moscow).





Equipment

In the design of ARKA we use CCD detectors of e2v company (UK) with the size of 6k×6k pixels – the largest ever used in the solar space missions.

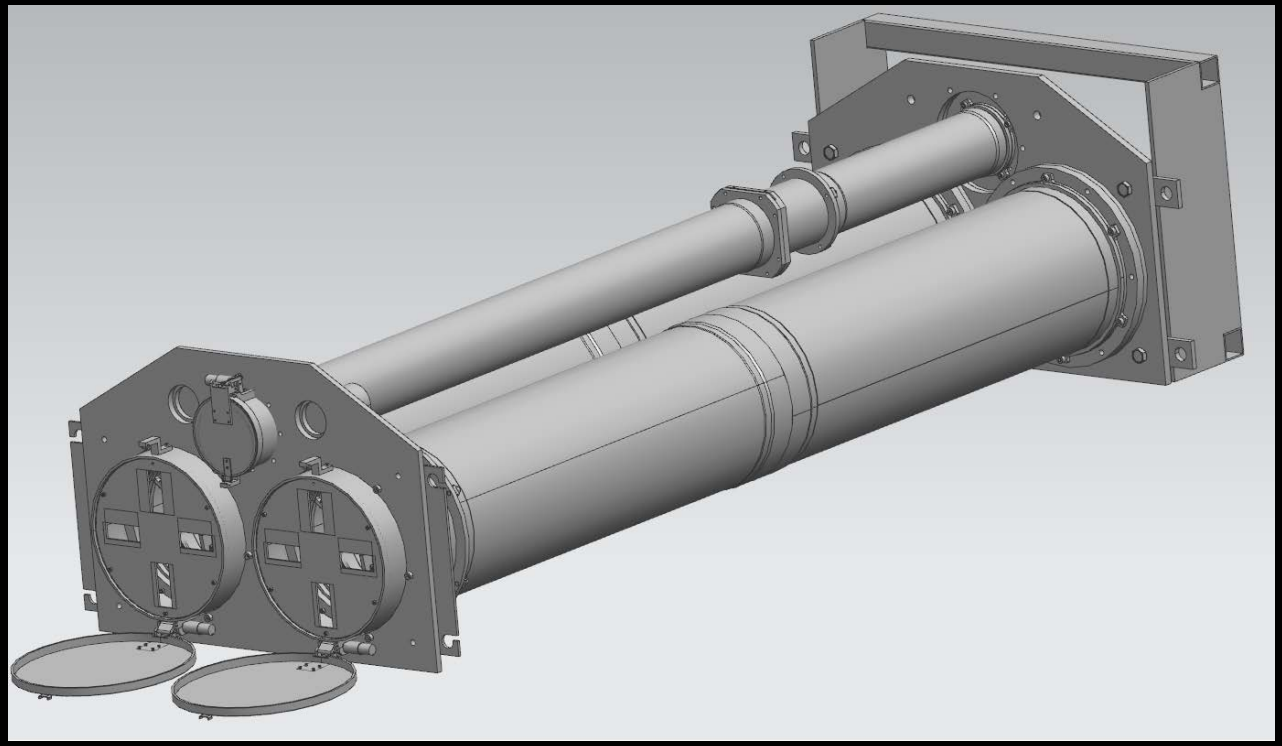
The image stabilization system is based on the piezo motors of PI company (Germany).

Schedule

The ARKA scientific equipment is developed from 2013. Currently the preliminary design of the instruments was fulfilled. The final design stage is in action.

The flight model is going to be delivered in 2021.

The launch of the SC is scheduled for 2023-2024.



Collaboration

We are open for any scientific and technical cooperation in the frameworks of ARKA project.

The principle scientific organization for ARKA mission:

Lebedev Institute of the Russian academy of sciences - http://www.lebedev.ru/en/

The project's PI:

Dr. Sergey Kuzin (Lebedev institute) – kuzin@lebedev.ru

Dr. Sergey Bogachev (Lebedev institute) – bogachev@lebedev.ru.

Thank you for your attention