

## **Invitation to participate in a Millimetron Science Working Group (v 01/10/19)**

We just finished a Millimetron workshop (9-11 September, Paris) where the development status of the Millimetron antenna and its expected in-orbit performance was presented.

See: <http://workshop2019.millimetron.ru/index.php/scientific-program>

Also, as the second goal of this workshop, a large number of interesting science cases were presented and discussed, highlighting the unique capabilities of a 10-m cooled FIR/Submm space antenna.

It was argued that for several of these cases Millimetron could make a great scientific “breakthrough”. These could be called Millimetron’s “killer apps”.

In order to build on these efforts, we would like to organize small working groups that write short but comprehensive descriptions of these important, unique science goals with a description of the instrument concept, its sensitivity and resolution, that would deliver with Millimetron the desired observational results.

For the Millimetron focal plane instruments we are clearly not aiming for a general observatory instrument complement. The selected instruments will be primarily driven by and optimized for the key science cases.

### **The Objectives for the working groups**

The objectives of the Millimetron Science Working Groups (SWG) are to define and describe the strongest science cases for the Millimetron Space Observatory (MSO) together with an associated instrument concept. One also may define and outline other important astrophysical areas where the MSO can uniquely and significantly contribute.

The resulting outcome should be a number of short but comprehensive paper-letters, that outlines the explicitly unique science rationale of the MSO with associated enabling instrument concept.

These notes, combined in a draft “red” book, will be submitted to a peer review whose recommendations will go to the Millimetron leadership. The final version of the red book will also be used for raising interest and funding from agencies, institutes and the astronomical community at large. As said, it will include the model instrumentation package and feasibility calculations together with Millimetron’s main characteristics.

### **Boundary Conditions**

Besides the general multi-wavelength/messenger considerations in establishing the science program for Millimetron, one can assume that for Millimetron the expected scientific results from the JWST mission and from ALMA will give strong directions. Other space missions and ground based projects, existing and forthcoming, can certainly also play an important role. In addition, it should also be kept in mind that Millimetron is the only planned space mission with high resolution (heterodyne) spectrometers and thus will have a unique strong capability.

### **Key science topics identified sofar.**

Below we have listed these topical areas. However, we are also welcoming additional topics, to be unique and very important, and can also considered as key science cases.

More details can be found in the workshop presentations that are on line.

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*1. Relativistic Astrophysics and S-E VLBI*

This topic concerns a further study of the very vicinity of the shadow around the SgrA\* and M87 black holes with EHT-Millimetron baselines, with multi-wavelength polarimetric observations. The study must be accompanied with a detailed paper on orbital choices, baselines and image quality.

*2. CMB spectral shape distortion*

This will address CMB spectral distortions,  $\mu$ - and  $\gamma$ - S-Z, recombination lines and foreground observations with a high precision, mm/Submm spectro- polarimeter.

*3. Compact Heavily Obscured Galaxy Nuclei*

Study of cold gas and dust that play a central role in feeding and regulating star formation and growth of supermassive black holes (SMBH), in heavily obscured galaxy nuclei, over cosmic time with high angular and spectral resolution and sensitivity

*4. The water trail (TBD)*

The role of water in the very earliest stages of star formation and the fate of water in the later stages of star and planet formation by high spectral resolution observations of spectral lines of gaseous water and related hydrides. It includes also water observations on solar system objects to understand the development of habitability in the process of planet formation.

*5. Filaments and magnetic fields on various scales*

Study of the role of magnetic fields in the formation and evolution of the interstellar web of dusty filaments giving birth to most stars in our galaxy by observations with a high dynamic and high-resolution imaging FIR/Submm polarimeter.

Other possible topics might be in the field of Astro-chemistry; Star and planet formation and evolution; Disks and exoplanets environment; etc

Important dates:

15 October 2019:	Submission of letter of interest to participate
23 December 2019:	Delivery of chapters on science cases
30 March 2020:	Review and recommendation by panel
30 April 2020:	Decision by Millimetron on selection of key science cases
7-11 Sept. 2020	Millimetron Conference

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