July 2021

IAF SPACE ASTRONOMY TECHNICAL COMMITTEE

1. Introduction/Summary

Ground and Space Astronomy synergy has recently permitted a phase of remarkable discovery and growth. Public recognition is the several Nobel physics prizes gained in (observational) cosmology, exoplanets, gravitational waves, X-ray astronomy, and astrophysical neutrinos. Although the field of astrophysics is vast, the SATC Committee concentrates its work in the area of space astronomy and in particular, serve as a forum for the exchange of information and interaction between the scientific community, space industry, and space agencies involved in the preparation and the future development of new astronomy missions. Therefore, the SATC action will cover the very early phases of mission conception before missions are proposed to the Agencies for assessment. As such, the SATC role comes up-front and is largely complementary to the current work that the Agencies achieve. Its principal intended role is to enable or improve the emergence of new science mission concepts.

2. Latest Developments: the large scale, flagship missions, strategic missions.

2.1 The present scenario

The use of space techniques plays a crucial role in advancing astrophysics by providing access to the entire electromagnetic spectrum from radio to gamma rays. NASA's Chandra observatory and ESA's X-ray XMM/Newton observatories have been operating successfully in space since 1999, while NASA's Hubble Space Telescope entered its 32nd year of operation. At higher energies, the Neil Gehrels SWIFT Observatory, INTEGRAL, Agile, and FERMI gamma-ray observatories continue 15-20 year operation along with a suite of other space observatories like NASA NICER and NuSTAR, ESA Solar Orbiter, ISRO ASTROSAT, Chinese HXMT, Japanese MAXI, and Cubesats from various countries. The achievement obtained by this impressive fleet of space observatories in Astronomy, Astrophysics, and Astroparticles has been recently boosted by the newly emerged field of ***Multimessenger*** physics. Observations in this new field of front-line research include detection of electromagnetic counterparts of cosmic phenomena seen in different "windows": Gravitational Waves, Neutrinos, Fast Radio Bursts, and High Energy Cosmic Rays observed in parallel in the classic electromagnetic band.

The second version of this report, due by the end of 2021, will address planetary science and other topics not included in the current version.

2.2 Future perspective

The increasing size and complexity of large space-based observatory missions place a growing emphasis on international collaboration. This is particularly marked by the increasing range of joint missions involving space agencies in Europe (ESA), United States (NASA), Japan (JAXA), the Russian Federation (RKA) and China (CNSA), India (ISRO), and more recently, the United Arab Emirates (UAESA), and others. The Astronomy and Astrophysics Decadal Survey (US: Astro2020) and the ESA Cosmic Vision (EU) outline a comprehensive research strategy and vision for a transformative science at the frontiers of astronomy and astrophysics in the next decades. Similar plans, though at a lower level, are ongoing under other major national space agencies mentioned before. In particular, large scale flagship missions like the Athena X-ray Observatory, LISA GW explorer, the Jupiter icy moons Explorer (juice) (ESA), Nancy Roman Space Telescope (NASA), and medium-size missions like Euclid, PLATO, and TESS, and Starburst are already operative, approved, or in the realization phase. This impressive fleet of space observatories will be complemented during this decade by large-scale ground-based facilities like TMT, ELT (ESO), SKA, CTA, and others, spanning from radio to optical/IR to high energy gamma rays. The new observational window

opened by the GW interferometers and Neutrino detectors are under upgrade and optimized to be inter-operative with other ground-based infrastructure and space-based missions.

3. Breakthroughs

Only a few examples among many possible ones are mentioned below:

1. The James Webb Space Telescope. Due to launch in October 2021, JWST will delve into the mysteries of the end of the Dark ages and first light and re-ionization in the early universe, the assembly of galaxies, the birth of stars and protoplanetary systems, and the origins of life. These thematic mysteries will be investigated with this facility-class observatory, providing breakthrough science and understanding of phenomena never before observed with such exceptional capabilities. As a result, JWST is poised to fundamentally alter our understanding of the universe.
2. High Energy: significant correlation between INTEGRAL soft gamma-ray and ground detected TeV sources https://www.cosmos.esa.int/web/integral/pom
3. Spectrum RG is a Russian–German high-energy astrophysics space observatory launched on 13 July 2019 and now providing the deepest sky survey in the energy range 1-15 KeV. Planned in operation for 6y.
4. CSES (China Seismo-Electromagnetic Satellite) scientific space missions are dedicated to monitoring electromagnetic field and waves, plasma and particle perturbations of the atmosphere, ionosphere and magnetosphere induced by natural sources and anthropocentric emitters, and to study their correlations with the occurrence of seismic events. The first satellite continues flawless operations, the second to be launched at the end of 2022.
5. An issue of significant concern is the impact of large LEO constellations on astronomy (see IAU paper). To address the anticipated dramatic impact of the large number of small satellites constellations (up to 10k) for commercial use, an IAF task group with the TC26 Traffic Management committee is operative.
6. Education, Diversity & Inclusion, and Outreach. Many NASA programs are using dual anonymous review for leveling the access to observatory resources. Citizen Science programs serve to engage a diverse cadre of individuals in contributing to research based on NASA resources, and research results continue to infuse outreach and education activities and materials in the full suite of scientific topics.

4. Action plan for the year

The main SATC activity for the current year will be focused on:

1. Continuation of the long term analysis of the “technical, scientific and programmatic areas of space astronomy and in particular serve as a forum for exchange of information and interaction between the scientific community, space industry and space agencies involved in the preparation and the future development of new astronomy missions.” Particular emphasis is on technological breakthroughs for future space applications (e.g. space cryogenics systems, cubesat constellations, space-ground synergy). As such, the SATC role will be complementary to the current work carried out by the Agencies, industries, Academia and space and ground-based stake-holders;
2. Organization of symposia, first of all the A7 in Dubai, for the discussion and publication of ideas and results on topics of relevance in particular to the impact and future needs of astronomy missions in space technology;
3. Provide a point of contact for national and international bodies.

The Action plan foresee: IAC2011 sessions, active participation to COSPAR 2022 (Athens) and 2023 Space science with small satellites (Singapore), IAU Busan 2022, IAU las Palma UNOOSA, ISSI Forum on “Ground and Space Astronomy: Challenges and Synergies“.