Swiss Participation in SKA Science working groups

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On behalf of the Swiss SKA Science working groups

SKA Science working groups (SWGs)

- SWGs provide a conduit for interaction between the SKA project and the astronomical community: https://astronomers.skatelescope.org/science-working-groups/
- Two tiers of membership: core and associate

+ Science Working Groups & Focus Groups
+ Cosmology
+ Cradle of Life
+ Epoch of Reionization
+ Extragalactic Continuum (galaxies/AGN, galaxy clusters)
+ Extragalactic Spectral Line
+ Gravitational Waves
+ HI galaxy science
+ Magnetism
+ Our Galaxy
+ Pulsars
+ Solar, Heliospheric & Ionospheric Physics
+ Transients
+ High Energy Cosmic Particles (Focus Group)
+ VLBI

Swiss involvement

- Switzerland is already active in the SKA SWGs, with representatives from the science community in several SWGs
- Swiss scientists lead and participate in many science projects of the SKA
- Areas of Swiss science involvement are very broad and summarised in the Swiss SKA White paper: https://www.epfl.ch/labs/lastro/wp-content/uploads/2020/02/White-paper_Swiss-interest-and-contribution-in-SKA.pdf
- Swiss scientists are currently members of the Cosmology, Our Galaxy, Cradle of Life, Gravitational Waves, Cosmic Magnetism, Transients, Solar Physics and Extragalactic Spectral Line Science working groups.
- Swiss involvement in forthcoming slides - listed: interest (in the white paper), red: membership in the SWG

Cosmology

- Hydrogen gas in the intergalactic medium can be probed by its hyperfine 21 cm transition. Intensity maps from the collective HI emission trace large scale structure in the early universe. HIRAX involvement: arXiv:2109.13755, new estimator for gravitational lensing: Jalilvand et al. PRL (2020), bispectrum in redshift space: Durrer+ JCAP (2020), cosmology forecasts and cross-correlations with galaxy surveys (HP, Refregier, Amara, MNRAS 2019, 2020)

- SKA maps evolution of structures at the largest scales, allows to design new tests of Einstein's general relativity, the cosmological principle: Franco, Bonvin and Clarkson, MNRASL (2020)

- SKA surveys will enhance our understanding of the faint imprints of the primordial period of inflation, the early stages of galaxy formation, the nature of dark energy and dark matter: Fundamental Physics with the SKA (co-lead: HP, PASA, 2020); constraints on dark matter models with CTA : Korochkin, Neronov+ (JCAP, 2020), Lyman-alpha forest constraints: Garzilli+ (2021)

- Swiss involvement: **Marta Spinelli (co-chair Cosmology),** Jean-Paul Kneib, Martin Kunz, Frederic Courbin, Andrej Obuljen, Joachim Staedel, Camille Bonvin, Hamsa Padmanabhan, Ruth Durrer, Alexandre Refregier, Devin Crichton, Andrii Neronov, Alexey Boyarsky …

Cradle of life

- First discovery of an extrasolar planet around a Sun-like star by Michel Mayor and Didier Queloz (Nobel Prize 2019)
- Launch of CHEOPS in December 2019 led by Willy Benz
- SKA will be used to search for amino acids and faint radio signals.
- Dusty disks around Sun-like stars (the “habitable zones”) can be probed with SKA with unprecedented resolution and sensitivity.
- VLA survey of young stellar objects in Oph A cluster, Coutens+ (A & A, 2019)
- Swiss involvement: Maria Drozdovskaya, Greta Guidi, Marc Audard, Lucio Mayer, Suzanne Wampfler,…

Extragalactic Spectral Line and Extragalactic Continuum

- Extragalactic spectral lines such as HCN, HCO+, HNC, CS as tracers of molecular gas, complementary to ALMA surveys
- CO 1-0 line accessible at z > 7.3 with the SKA, GigaERIS mocks at high-z following Tamfal et al. (2021, to appear in ApJ, arXiv:2106.11981)
- ALPINE - ALMA CII survey, simulations like SPRITZ; Jones+ (MNRAS, 2021), Bisigello+ (PASA, forthcoming), COLDz star formation constraints (ApJ, forthcoming), DRAGONS and FIRE simulations of early galaxies, BlueMUSE project (arXiv:1906.01657)
- Swiss participation to several recent or on-going surveys targeting continuum emission at both sub-mm and radio bands, e.g.: A3COSMOS, VLA-COSMOS, the e-MERLIN LIRGI survey, and MeerKAT/ASKAP precursor surveys
- Radio continuum emission as a star-formation rate tracer
- Swiss involvement: **Mark Sargent (co-chair Extragalactic Continuum),** Miroslava Dessauges, Robert Feldmann, Pascale Jablonka, Pascal Oesch, Anne Verhamme, Lucio Mayer, Yves Revaz, Daniel Schaerer, Aurel Schneider …

Gravitational waves

- SKA enables stringent strong-field tests of gravity by enhancing pulsar timing arrays (PTAs), detecting nHz frequency gravitational waves
- This is complementary to mHz frequency waves detected by LISA
- A SKA-LISA observatory can determine the redshifts of cosmological standard sirens, measuring Hubble constant to < 1% and cosmic acceleration to < 10%
- Tidal disruption events around IMBHs detectable with SKA in combination with Athena (Pestoni+ 2021, MNRAS 500, 4628)
- Constraining the parameters of the MBH in the Galactic Centre (Zhang & Saha, ApJ 2017)
- Swiss involvement: Antonio Riotto, Philippe Jetzer, Michele Maggiore, Lucio Mayer, Prasenjit Saha …

Magnetism

- SKA will measure extremely faint radio sources probing the history of cosmic magnetism in galaxies, with 10 times better resolution than current telescopes.
- SKA's resolution will enable accurate measurements of magnetic fields in clusters and surrounding filaments
- SKA combined with the Cherenkov Telescope Array (CTA) will provide powerful constraints on intergalactic magnetic fields. These are potential probes for fundamental physics shortly after the Big Bang [e.g. coupling between magnetic helicity and chiral asymmetry (Schober+, PRD 2020)]
- Swiss involvement: Ruth Durrer, Simon Lilly, Andrii Neronov, Jennifer Schober …

Our Galaxy

- Milky Way ISM and molecular cloud studies (including the flow of material, Galactic spectral line work)
- Proper motions of young stars in nearby clusters/clouds (including tomography)
- Parallax and distance measurements of objects throughout the Galaxy
- Variability studies throughout stellar evolution (young, MS, evolved, SNR)
- Detailed (resolved) studies of individual low- and high-mass star-forming regions
- PRISTINE survey probing the first stars in our Galaxy
- Swiss involvement: Marc Audard, Annalisa de Cia, Pascale Jablonka

Solar, heliospheric, ionospheric physics

- Radio (synchrotron) and hard X-ray (bremsstrahlung) are complementary diagnostics of flare-accelerated electrons.
- FHNW developed state-of-art X-ray imager STIX (PI: Sam Krucker) on-board Solar Orbiter (Krucker+ 2020).
- Sensitive SKA solar maps along with STIX X-ray observations will provide a detailed understanding of particle acceleration.
- Flare Studies from RHESSI (Solar X-ray imager) and VLA (radio L-band) provided a proof of concept in micro flares (Sharma et al. 2020; Battaglia et al. 2021).
- Radio storm observed by Parker Solar Probe mission (Harra+, A&A, 2021)
- Swiss involvement: Marina Battaglia, André Csillaghy, Rohit Sharma, Louise Harra, Säm Krucker …

Transients

- Studies of Gamma Ray Burst (GRB) ‘afterglows’ in the radio band which point to the nature of the GRBs
- Neutron star merger event - kilonova : synergies with multi messenger probes
- SKA acts as an FRB ‘discovery machine’ alerting follow-up discoveries in the multi messenger regime
- Involvement in INTEGRAL
- Swiss involvement: Carlo Ferrigno, Teresa Montaruli, Andrii Neronov, Nicolas Produit, Volodymyr Savchenko

Outlook

- All SWGs are open to new self-nominations from prospective members
- To join a particular SWG, please contact the SWG chair(s) directly, or a member of the SKAO science team (https://astronomers.skatelescope.org/scientific-contacts/)
- SKA Science Meetings are regularly organised
- It is foreseen that the SWGs will provide a forum for discussion of Key Science Project concepts
- Swiss SWG members can share relevant information at regular occasions