Session: Technology and methods II

New methods for VLBI observations and the associated science opportunities (invited)

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I will present the current progress and future potential for VLBI performance, with a focus on the current arrays but also for future observations with SKA and other next-generation interferometers. We are in a moment of great promise as the multiple next-generation radio facilities, on the point of or in construction, will provide a huge boost in sensitivity and frequency coverage. These advances are being matched by developments of next-generation methods that will ensure the current systematic limits can be overcome - to deliver on the potential and enabling transformational science.

Foremost among these new methods are MultiView and Source/Frequency Phase Referencing. The former has demonstrated an increasing number of astrometric measurements with outstanding performance, reaching the thermal noise limit of the current VLBI networks. We can expect an order of magnitude improvement for SKA-VLBI with per epoch errors of $\sim$10uas at 1.4GHz and per epoch errors of $\sim$1uas above 8GHz. The technological requirement for this is an upgraded network of antennas that match the SKA capabilities for multibeam observations. Source/Frequency Phase Referencing requires multifrequency observations, and this is particularly timely, given the equipping of three Italian stations with compact triple-band receiver technology that will enable global SFPR experiments. Initially these will mainly be with the Korean network that was a pathfinder for this method, but also with a rapidly increasing number of similarly equipped European stations. A recent development is that a similar approach will also be applied up to 340-GHz, with the ngEHT. Finally the long baselines of ngVLA will have multiple antennas at each station. We will discuss how these can be used to perform both of these style of observations, enabling astrometric applications upto 120-GHz.

With all of these new capabilities on the horizon the future, at 40, is burning as bright as a ruby.

Celebrating 40 years of astrometric and geodetic VLBI data – a solid foundation for celestial and terrestrial reference frames (invited)

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Very Long Baseline Interferometry (VLBI) is a measurement technique at radio wavelengths, which is used - among others - for astrometric and geodetic purposes providing a unique source of data for the creation of global celestial and terrestrial reference frames. Furthermore, it is the only measurement technique that provides the full set of Earth orientation parameters, which describe the connection between the two reference frames. In this talk, I introduce the latest VLBI celestial and terrestrial reference frames VIE2022 computed at TU Wien which include VLBI data until December 2022. They can be seen as an extension of the current International Celestial and Terrestrial Reference Frames, the ICRF3-sx and ITRF2020, which incorporate the VLBI observations at the standard S/X band frequencies (2.3/8.4 GHz) until March 2018 (ICRF3-sx) and December 2020 (ITRF2020). In the framework of the K band collaboration, a celestial reference frame at the frequency 24 GHz is also estimated at TU Wien. Over 99% of the K band single frequency data are produced by the Very Long Baseline Array (VLBA), which induces challenges in the data analysis connected to the geometry of the telescopes placed in the territory of United States. Furthermore, the latest terrestrial reference frames incorporate data from the novel VLBI Global Observing System (VGOS) which is based on the broadband delay using several frequency bands in the range from 2.5 to 14 GHz. The first test sessions were run in December 2017 and the regular observations started in January 2019. The challenges adherent to the position estimation of the newly built VGOS telescopes are addressed.

Introduction of Jingdong 120-m radio telescope

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In Jingdong County (101° E, 24.5° N), Pu'er City, Yunnan Province, the Yunnan Observatories Chinese Academy of Science will construct a 120-meter radio telescope dedicated to pulsar-related science. The telescope covers the frequency range from 100 MHz to 10 GHz (i.e., from the wavelength 3m to 3cm). Once finished, it will be the world's largest fully steerable single-dish decimetre-wavelength radio telescope. This topic introduces the scientific objectives and key technologies of JRT. The JRT will be driven by three major scientific goals, which include (1) long-term high-precision pulsar timing for time-frequency metrology and nanohertz gravitational wave detection; (2) pulsar astrophysics, fast radio bursts, gravity theory tests, and black hole physics; (3) deep space exploration, geodesy, and celestial reference system. We will also cover the engineering design aspects in this topic, and present current plan and design for the telescope mechanical structure, front-end, digital backend, and control system.

Synoptic Wide-field e-MERLIN EVN Programme

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The high angular resolution and sensitivity of VLBI offers a unique tool to identify and study AGN and star-formation activity over cosmic time. VLBI observations are crucial for identifying young radio sources and unveiling older restarted radio sources. Also, radio imaging over a large range of angular scales is needed to determine the role of black hole feedback and jet-induced star formation in galaxies. To answer these questions and to find rare radio sources, such as gravitational lenses and binary/dual AGN, all-sky VLBI surveys are needed. Despite recent technical advances, such as multiple phase centre correlation and multi-source self-calibration,