

DIVISION A

WORKING GROUPS

**Working Group
Chair**

**Future of the ICRS
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TRIENNIAL REPORT 2018–2021

Background

The WG on the Future of ICRS (abridged as ICRS-WG) was created at the IAU General Assembly in Hawaii in 2015, in order to anticipate the evolution of the ICRS with the advent of realisations in different wavelength domains. The WG was not formally discontinued in 2019. As of today, the different spectral domains concern primarily the realisation(s) in the radio domain with the VLBI observing technique on one hand, and an optical realisation(s) coming from the European space mission Gaia. The WG was also in charge of evaluating the alignment procedures between the different realisations and investigating the possible systematic differences between the radio and optical positions of the sources contributing to these realisations. This WG stood on the side of the ICRF-WG in charge of producing the 3rd release of the radio realisation (referred to as ICRF3). The ICRS-WG comprised 11 members including three representatives from the ICRF-WG and three people with deep involvement in Gaia astrometry.

Report

In 2016 Gaia produced its first data release (Gaia-DR1), but without a full astrometric solution for the quasars. The corresponding reference frame was limited to the 2191 sources common to ICRF2 and aligned to the latter. The position catalogue of 1 billion stars and the TGAS solutions with full astrometry were given in this frame and provided a secondary access.

A true first version of a full realisation of an ICRF in the optical domain with Gaia

based on $\approx 550,000$ extragalactic sources appeared in April 2018 while the updated radio version ICRF3 was released during IAU GA in summer 2018 to become the international reference as of 1st January 2019. It included three largely independent solutions in as many passbands. In parallel Gaia pursued its observation program leading eventually to a new version of the Gaia-CRF in December 2020 with above 1.6 million compact sources. While the Catalogue is available, the official paper presenting the properties of the frame is not yet finalised. Therefore the last three years have been a transitional period with the availability of the radio ICRF (ICRF3) at the beginning and the Gaia-CRF3 almost at the end.

The previous report for 2015-2018 concluded with several recommendations not mature enough to be turned into resolutions in 2018. They dealt with the definition of the primary realisations, the alignment procedures between the realisations in different wavelengths, the mutual comparisons to detect possible systematics on scales not removed by the alignment and pointed out to the difficulty of defining what is actually understood by alignment. In particular one objective mentioned in the 2018 report was stated as *radio and optical frames are for the time being complementary and should have in the future similar status as primary realisations of the ICRS*. There was a clear need to clarify the respective role of the radio and optical realisation and avoid confusion for the users on how to deal with two realisations with similar accuracy, but very different accessibility.

The matter was presented during the IAU 2018 and further set forth at the Journées organised in Paris in October 2019 and discussed between attending members.

The working group has examined the current situation with the goal of preparing a resolution to reach a broader definition of the ICRF able to encompass realisations established in different bandpasses. This resolution has been submitted in due time to the IAU General Secretary for consideration and formal approval during the IAU GA of 2021.

But other issues like the epoch of a realisation, the way to handle the Galactic acceleration, the overall terminology, the future Gaia releases, etc, appeared during the exchanges between members, that needed more time to be settled. We then decided to limit the action of the existing WG to submit a single item resolution to define a unique framework for an approved set of realisations in different wavelengths as making the ICRF.

A new WG is proposed to the IAU Division A, with a composition better reflecting the new objectives. It should gather competences in techniques dealing with the optical and radio realisations but also with the physical properties of the sources since the positional variability, the offset between solutions in different bands are intimately related to physical processes.

F. Mignard

on behalf of the ICRS Working Group