The ICRS, BCRS and GCRS, ITRS:

astronomical reference-systems and frames in the framework of Relativity, problems of nomenclature

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Theoretical concepts	Observations, experiments, tests
• coords in manifolds with metric tensor g	
LEVEL 1	
• space-time manifolds (dim=4, sign(g))	general properties of space and time
• g satisfies Einstein's GRT	tests of GRT
LEVEL 2	

- post-Newtonian framework — specific tests
- definitions, e.g., for centers of mass (barycenter)
- idealization, e.g., solar-system as isolated N-body problem — solar-system obs. tests of idealizations (e.g., external tidal forces)
- special coordinate conditions

  local conditions $X \to 0$
  ($g \to \eta$ for $T_{ss} \to 0$; locally inertial)

  asymptotic condition $R \to \infty$
  (e.g., $g \to \eta$; asymptotically inertial)

  conditions to relate local with asymptotic metric (e.g., gauge)

BCRS $[(x^{\mu} = (ct, \mathbf{x})); g]$

- orientation of spatial coords not fixed;
  can principally be done in many ways

special coordinate transformation
leads to **GCRS**; due to its acceleration
it is only a LOCAL system
(no asymptotics)

solar-system
ephemerides

LEVEL 3

The ICRS concept and cosmic assumptions

Idea: the fundamental astronomical reference system should show no global rotation (quasi-inertial system)

Cosmic assumptions on the distribution of matter on very large scales and the world model:

- cosmological principle: universe on very large scales is homogeneous and isotropic
- distant matter is at rest w.r.t. BCRS
- QSOs show only random tiny proper motions

- ICRS concept

cosmol. observations;
tests of Cosmol.Principle
and wold-models

- cosmic idealizations

detailed QSO
observations (hot spots;
structure; variabilities etc.)

- auxiliary conditions for (α, δ)
  (e.g., to fix origin of α)

identify fiducial marks

observe (relative) positions

ICRS

ICRF

LEVEL 4

Different standpoints towards a ICRS-definition

The complete set
of rules (math./others)
to construct the ICRF
(incl., DE-ephemerides,
atmosph. model etc.)

BCRS +
cosmic assumption

Points that might be of relevance for problems of nomenclature

1. With increasing accuracy the definition of a system requires more and more observations; the distinction between a system and its frame becomes more and more problematic

One idea is to speak about:

- ICRS concept (an idealization)
- ICRF
- ICRS as coordinate system determined by the ICRF

Points that might be of relevance for problems of nomenclature

2. The ICRS and the BCRS appear at different levels of abstraction. In principle the spatial BCRS-axes could be fixed by different techniques. Presently they are determined by the ICRS but the nomenclature should be such that the BCRS is defined principally without reference to the ICRS

3. W.r.t. astrometric observations:
the BCRS and the GCRS allow relativistic meaningful definitions of:

catalog places, proper (GCRS) places

If a massless observer is considered instead of the geocenter a TCRS can be defined (kinematically non-rotating w.r.t. the BCRS (GAIA)

HOWEVER, azimuth and elevation have not been defined consistently; one needs a consistent post-Newtonian treatment of diurnal parallax, aberration and ‚horizon axes‘