Radio Sources with large changes in the apparent coordinates

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Abstract

The current (third) version of the International Celestial Reference Frame (ICRF), known as
ICRF3, is based on the Very Long Baseline Interferometry (VLBI) data at the standard radio fre-
quencies (8.4 and 2.3 GHz). It comprises positions of 4536 extragalactic radio sources, 303 of them
are so-called "defining" ones and used to fix the fundamental axes of the International Ce-
lestial Ref-
erence System (ICRS) with the accuracy of about 30 microarcsec. In addition, some radio sources
known to be astrometrically unstable were not included to the list of reference objects.
The ICRF3 was officially adopted in 2018, and by that date the positions of the most unsta-
ble
radio sources are believed to vary within 2-3 mas. However, we recently found some radio sources
that expose extremely large positional instability (up to 130 mas) on the time interval from 3 to 30
years. This is far beyond of usually expected instability, therefore it attracts so much atten-
tion.
Herewith, we conducted a systematic search of similar objects using the time series of radio source
coordinates between 1993 and 2022. All VLBI observations from the International VLBI Service
(IVS) database were used, and more than 5000 extragalactic objects were investigated. Fi-
nally, we
identified 65 objects with the positional change exceeding 5 mas. They could be sorted on three
categories of instability:
1. "bouncing" first and last points (24 objects),
2. "step" at the position time series (25 objects),
3. steady apparent proper motion (19 objects).
Three of the radio sources are unstable by two categories.
At the first category, 1306+660 demonstrates the highest rebound (first point in time series),

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as
between 2017 and 2018 the coordinates changed on $\alpha \cos \delta = 19.2 \pm 4.4$ mas in right ascension and
$\delta = 39.4 \pm 7.1$ mas in declination.
At the second category, the record-breaker is 1328+254. There is an abrupt change in coordinates
between 2014 and 2019 on $\alpha \cos \delta = 84.7 \pm 1.2$ mas and $\delta = 114.7 \pm 1.4$ mas in right ascension
and declination, respectively.
The highest detected proper motion is found for radio source 0350+177, $\mu\delta = 25.7 \pm 6.8$ mas/year
using the 6 observations between 2018 and 2022. The total positional shift in declination is 102.2±2.7
mas for the 4 years.
In the context of making the next ICRF realization, such radio sources should be moved into the
list of astrometrically unstable objects.