From: **Astronomy & Astrophysics** aanda.paris@obspm.fr
Subject: AA/2020/38179: referee report
Date: May 12, 2020 at 01:14
To: liuniu@smail.nju.edu.cn

11/05/2020

Mr Niu Liu

liuniu@smail.nju.edu.cn

Our Ref. : AA/2020/38179

Dear Mr Liu,

Your paper "Comparison of multi-frequency positions of extra-galactic sources" was submitted to a referee who recommends publication after substantial revision (see enclosed report).

Please take the referee's comments and suggestions into account in revising your work and send us the new version (in referee format and in printer format) at your earliest convenience.

Instructions for resubmission can be found at address https://mms-aanda.obspm.fr/is/aa/resubmit_a_paper.php. Your author ID number is 28144.

- In your cover letter, please indicate precisely all the changes made in the revised version. Please also include your detailed responses keyed to the items in the report.
- Mark all the changes clearly (using boldface or latexdiff) in your manuscript.

The deadline for the submission of your revised version is three months.

With best regards,

Thierry Forveille
A&A Editor

Referee Report

Paper of "Liu et al." is about analyzing differences of three ICRF3 sub-catalogues, X/S, Ka, K, against Gaia DR2. I think this paper is publishable after a major revision.

I should first note that the authors incorrectly label a table http://hpiers.obspm.fr/icrs-pc/newwww/icrf/icrf3sx.txt as ICRF3 X-band. It is wrong! One can produce X-band only icrf3-x catalogue, but it would have different properties than icrf3sx.txt table. icrf3sx.txt table is made from processing ionosphere-free linear combinations of X-band and S-band group delays. Authors must replace everywhere 'X-band' with dual-band S/X, 'X-to-K' to "S/X-to-K' etc. This is a very serious mistake. Fortunately, it is rather easy to fix it.

In a similar way, the authors thoughtlessly use word "quasar" as a substitute to 'source'. The authors should refrain from using word quasar for radio sources unless they performed classification and found firm evidence that a given source is a quasar, but not BL Lac, radiogalaxy etc. (Only a fraction of ICRF3 sources are quasars). This is not a quibble, since in the context if this publication, source classification matters. A subset of quasars may have different properties than a subset of BL Lacs.

Two other major shortcomings are a) the study is unfocused; b) statistics are shown for a small subset of sources. For instance, statistics of jet direction is given for 4% of the sample, source structure index statistics is provided for 29% objects of the sample. The paper is clogged with illustrations that illustrate nothing. For instance, the authors show a difficult to read Figure 4 and gigantic table 4. I suggest to condense it to one sentence: we computed correlation between morphological indices, but no statistically significant correlation was found. The authors did not explain why a null result is interesting. Perhaps, because it is not.

I suggest to focus on source structure index as the main statistics.

The authors write in conclusion in page 8:

> Large radio-to-optical distances (> 1 mas) are usually associated with a large source structure index (> 3).

I looked at Figure 4 and I did not find this claim is substantiated.

In page 7 they write a contradictory statement:

> In general, the radio-to-optical distances show no or negligible correlation with the structure index.

I think this statement corresponds to what we see in Figure 4.
Unlike to other null results shown in the paper, this null results has
a value and justifies publication.

The authors wrote in page 1:

> The K- and Ka-band observations suffer less
> from the radio source structure and ionosphere and solar plasma
> effects than those at X-band (e.g., Jacobs et al. 2002).

The first part of the statement about source structure is partly true.
Jacobs et al. indeed made this statement, and the statement was repeated
in a number of other papers, but in a form of a hypothesis.
{ I should note in brackets since icrf3 sx table used S/X ionosphere-free
linear combination of observables, the ionosphere contribution on K-band and
Ka-band position estimates is greater (not less!) than on S/X }. Apparently,
the authors of this manuscript found a lack of a relationship between Gaia/icrf3
position differences and source structure index (SI). This may happen because
a) SI is a poor measure of the source structure contribution; b) source
structure contribution is negligible on any SX, K, or Ka positions; c) source
structure contribution is not negligible but almost the same for SX, K, or Ka
positions. The authors have the data that allow them to test these hypotheses.
But in order for the results to be meaningful, the SI for every source in
the sample of 488 objects should be used. Restricting the analysis to 29%
of the objects in the sample with an unknown selection bias does not allow
us to draw a meaningful inference.
Images of all the sources are publicly available. The authors should compute SI
for the rest of the sources. I also suggest to compute rigorous statistics
for ICRF3/Gaia versus SI relationship.

I think the authors can keep plots with the relationship ICRF3/Gaia versus z,
since they have redshifts for 91% of the sources, but I suggest to remove
Figure 8 and related discussion since only a 4% subsample is used.

> The position angles of K-band, Ka-band,
> and Gaia positions with referred to the X-band position are plotted in Fig. 6. Peaks at around 0 , 180 , and 360 could be ob-

I would put it in section 3.2 and explain the meaning of these peaks.
The peaks at 0/180 corresponds to declination errors. The larger the peak,
the larger the errors. Looks like the peak for the Ka catalogue is statistically
more significant than for the S/X catalogue . I think it is important to quantify
relative statistical significance of peaks at S/X, K, and Ka wrt Gaia. It is
important to understand which the catalogue S/X, K, or Ka suffers stronger from
declination errors, and reporting these results is worth publishing in A&A.

Other comments:

1) page 1L

> quasars with a precision close to the VLBI ones. The comparison between Gaia and VLBI positions measured at 8 GHz shows
> excellent agreements on the level of 1 mas except for about 6%-

8 GHz --> dual-band 2/8 GHz ; measured --> derived

2) Page 1R

> These studies, however, are only limited to the VLBI positions at X-band.

X-band --> dual S/X observations
and in many other places

3) Page 2L

Para started with

> Even the ICRF3 and the Gaia-CRF2 are both the realizations

It is a long paragraphs, but it can be condensed to one sentence:
we assume that all catalogues may have distortions, and first want
to remove them.

/ this is the right thing to do. /

4) Page 2R

> Besides, we considered the source morphological proper-
> ties in both optical and radio domains, characterized by (opti-

I suggest to remove the analisis of morphological indices since no result
worth mentioning was obtained. Or to condense the result to one sentence.

5) Page 2R

> However, this effect
> would be less significant for sources locating far away from us,
> that is, with a high redshift.

this is true if a) space is Euclidean; b) AGN emission is
isotropic; c) Doppler boosting is negligible. All statements are strongly
violated. If the authors want to defend this statement they should provide
a justification, considering luminosity function, AGN evolution, beaming, etc.
It is not trivial. Or the authors can just omit it and write something like
"we were curious, is there a dependence of the offset with redshift".

6) Page 3R

> The agreement between K-band
> and X-band positions is around 0.1 mas on the right ascension;
> the declination scatter is slightly larger, making the scatter cloud
> elongating along the declination axis. This phenomenon is more
> pronounced between Ka-band and X-band. The distribution of

See the comment above. It is important to elaborate. This is an
indication of declination errors of K and Ka catalogues. A study of these
errors deserve a special section. In particular, it is important
a) to learn which catalogue is more affected by declination errors;
b) quantify the effect; c) explain the origin.

7) Page 4

Tables 2 and 3 are too many numbers. I suggest the authors to ask themselves:
are all these numbers needed? What conclusions a reader is supposed to draw?
I suggest either highlighting with bold these numbers that are strongly
significant (f.e. D3 and M20 for Ka - X), or to write that most parameters
were in a range of 10-30 muarcsec, except D3 and M20 for Ka - X that are
-242 \pm 12 and 155 \pm 11 {μ}as respectively and then drop tables 2 and 3.

8) Page 4L

> No statistically obvious evidence from our sample shows that the
> radio-to-optical offset decreases at high frequency.

This is an important statement! That is why I recommend publishing a
revised manuscript. There were claims in the literature that positions from
high frequency catalogues are "better", but they were in a

I suggest authors think thoroughly of all implication
and try to develop them. This is the central result of the paper. What
are the consequences of this statement?

9) Section 3.4

I suggest to make it a part of a separate section about declination
systematic errors.

10) Page 6L

> We empirically adopted a limit of 20 on the absolute RA

> We empirically adopted a limit of 30 on the absolute PA

I suggest to drop this paragraph: 55 or 22 objects of 488 sources do not form a statistics.

11) Page 7R

> The Gaia astrometric precision gets worse as one moves to

Lengthy and not convincing paragraph. Gaia position uncertainty grows with magnitude. Does this dependency explains entirely the correlation? Or not?
It would help to look at the normalized dependence: divide \rho by the \sigma \rho.
Does \frac{\rho{\sigma \rho}(mag) increase with mag?

12) Page 7R

> For instance, for 1315б╜058 the radio-to-radio offsets at X- and

I think a more probable explanation is that 1315-058 is just an outlier.
I suggest either drop this line, or perform a detailed study of 1315-058.

13) Page 7R

> The correlation offset between ground-based optical position and VLBI position for ICRF sources is not consistent. For example, Camargo et al. (2011); Zacharias & Zacharias (2014) report that the radio-to-optical offset increases with the structure index, while Assafin et al. (2013) do not detect any dependency.

It is necessary to mention that Zacharias & Zacharias and Assain compared VLBI position with positions from ground optical observations.
It would be instructive to look at Gaia positions of the objects these authors used and check whether Gaia positions confirm conclusions Zacharias & Zacharias and Assain made, or these were artifacts of unaccounted errors in ground optic astrometry.

14) Page 7R

> If all sources have an extended structure of a similar scale, the radio-to-optical offset would become less as moving far away from us. It means that the radio-to-optical offset will decrease with the redshift, that is, the radio-to-optical offset is positively correlated with the redshift. This kind of correlation is

See comment 5 above.

15) Page 8L

> and X-band position. For seven sources whose four positions are aligned with the Gaia position in the jet upstream, their multi

7 sources do not form any meaningful sample. I suggest to remove this paragraph.

Important comments: the authors used an unpublished catalogue they found on Internet. They thank in acknowledgment by name programmers who developed matplotlib graphic library, but they provide absolutely no credit to the authors of the icrf3 catalogue! Authors of this manuscript must contact with the icrf3 team and ask for a written permission to use icrf3 catalogue prior to its publication. If the icrf3 team will grant such a permission, I suggest the authors to ask the icrf3 team how to credit properly their work.