A status Report of the Working Group on Calibrators of IAU Commission 54

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ABSTRACT

Since its implementation by the IAU General Assembly in Prague, IAU Commission 54 (Optical and Infrared Interferometry) has spawned several working groups on scientific and technical issues common to all interferometers. Work on these topics is therefore of benefit to the community, and we will report on the status of the working group on interferometric calibrators. Active tasks include resources and tools necessary to make informed decisions on calibrator selections, as well as feedback mechanisms on suitability of calibrators for specific purposes.

Keywords: IAU, Interferometry, Calibrators

1. INTRODUCTION

Interferometers measure amplitude and phase of the complex visibility, which, by definition, are unity and zero, respectively, for an ideal instrument in the absence of the atmosphere observing an unresolved star through a monochromatic filter. In reality, the measured amplitude is always smaller due to atmospheric turbulence and instrumental degradation, therefore the amplitude measured on a science target has to be normalized by the amplitude measured on a calibrator.

A calibrator is an object with a known visibility. Since we need hundreds of them to enhance the chances of finding one near a particular science target, we choose single non-rotating stars without infrared excess, so that stellar atmosphere models may predict with confidence a diameter. If it is very small, there is no need to know more, as in this case the expected visibility is unity and the phase is zero.

Calibrators are rarely unresolved however, and if bright ones are needed, they tend to be big enough to require good estimates of their angular diameter. These are extracted from their absolute photometry by fitting a stellar atmosphere model or from their apparent magnitude and $(V-K)$ color (*Surface Brightness Method*[1]). In Fig. 1 we show the requirements to be met by a calibrator in order to achieve a desired maximum uncertainty for the squared calibrated visibilities.

Calibrator selection and maintainance in terms of feedback on suitability is directly or indirectly a task every interferometer faces, even if these tasks are partially offloaded to a Principal Investigator. Because of this commonality, the Commission 54 of the IAU on Optical Interferometry decided to implement a working group on interferometric calibrators. What, then, are the possible tasks for such a working group ?

- Review suitable selection rules based on astrophysical insight.
- Share data on calibrators especially if they turn out to be unsuitable for any reason.
- Survey existing lists and publications for their mutual consistency.
- Investigate the feasibility of dedicated observing programs
- Encourage or even propose a common format for exchanging calibrator lists.

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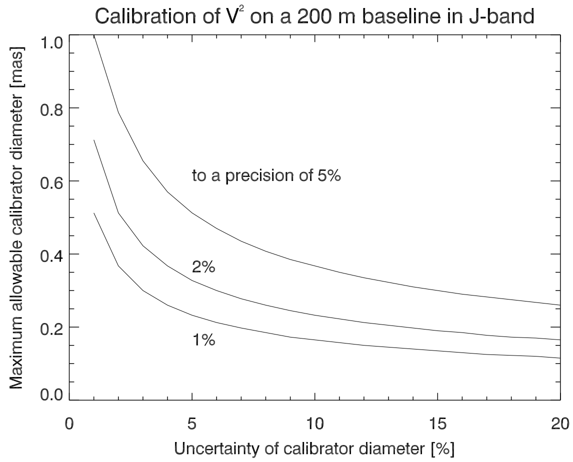

Figure 1. The figure shows maximum allowable diameter of a calibrator given its uncertainty in order to achive a specific calibration uncertainty.

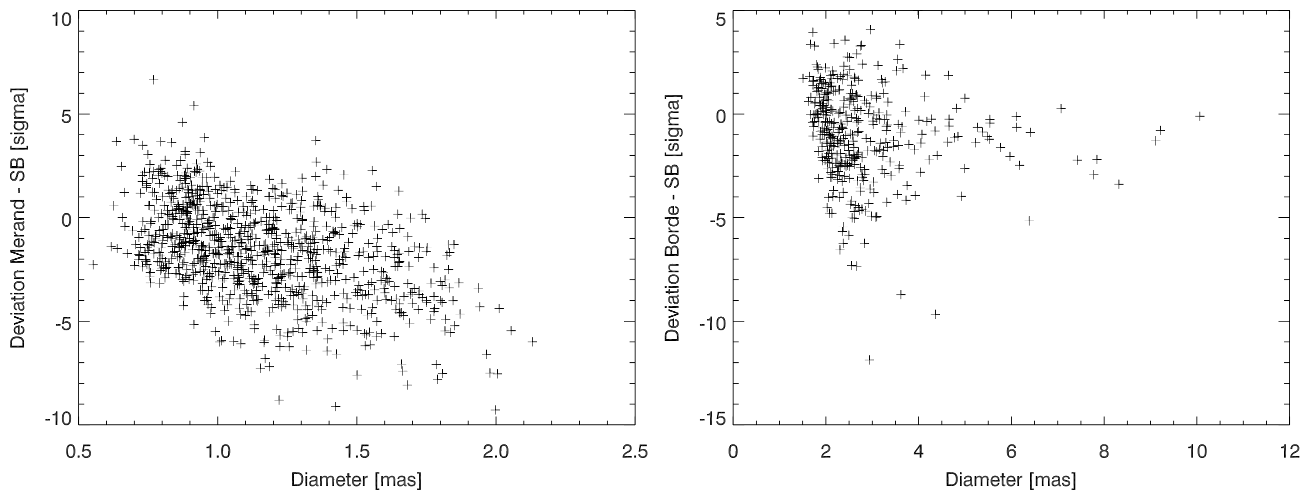

Figure 2. The deviation of diameters published by Borde[3] (left) and Merand[4] from estimates obtained with the surface brightness (SB) method, as a function of the SB diameter. The diameter catalog errors were added in quadrature to the adopted 3% error of the SB diameter estimates to derive the total diameter uncertainty. 35% (26%) of the diameters were consistent at the one-sigma level for Merand (Borde).

2. CATALOG TESTS

Some interferometers have published their calibrator lists,[2] others make use of published lists based on modeling,[3,4] and, finally, there are tools allowing on-the-fly selection of calibrators selected from external databases such as Simbad (e.g. ASPRO, see *http://www.jmmc.fr*).

To give a preliminary assessment of their quality in order to provide guidance for selection of calibrators, we compare in Figs. 2,3 the catalog diameters to those computed with the surface brightness method. While we do not claim that this method is the best, the necessary input data are more readily available, and Mozurkewich[1] has demonstrated an uncertainty of 3% for the diameters so computed of dwarfs and giants.

3. BAD CALIBRATORS

Despite all care that has been applied to the selection of suitable calibrator stars, there will be cases of bad calibrators, i.e. those with an expected visibility much different from what is measured. This can be due to

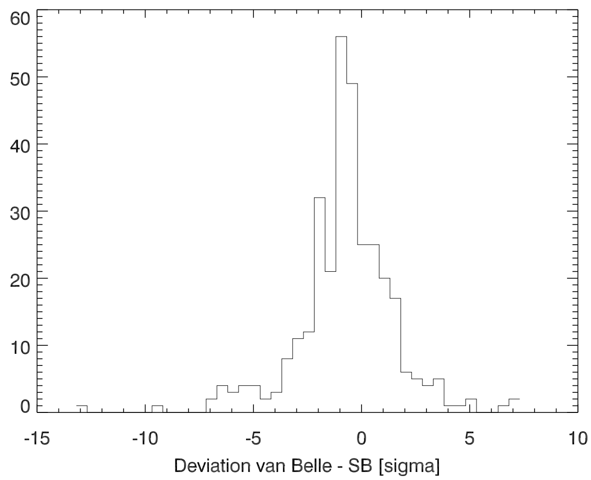

Figure 3. The deviation of diameters published by van Belle[2] from estimates obtained with the surface brightness method. 56% of the stars had diameters consistent to within one-sigma.

previously unknown companions, photometry errors (which have to be corrected in the data base), or maybe a peculiar atmosphere leading to wrong predictions. In any case, the applicable parameter space (e.g. baseline length and wavelength) is as important to know as the identity of the bad calibrator itself.

Currently, such a page is maintained by J. Monnier at *http://www.astro.lsa.umich.edu/ monnier/Local/calib.html*, which can receive new submissions and displays all relevant information. As long as researchers submit their cases of bad calibrators, this data base will continue to be useful. The calibrator working group could monitor new submissions and also survey papers for information on calibrators used or possibly rejected. Furthermore, follow-up of bad calibrators could lead to interesting scientific results.

4. FORMATS

Before becoming IAU Commission 54, the working group on optical interferometry had successfully implemented a format (OIFITS,[5]) which is is used worldwide to exchange interferometric data. Part of this FITS format is a binary table containing stellar data such as positions and proper motions. We would like to suggest a second revision which should include the following new fields.

- Limb-darkened diameter
- Effective temperature
- Logarithm of surface gravity
- Coefficients of second-order polynomial fit to linear limb-darkenening coefficients between 450 nm and 20000 nm.

The limb-darkening coefficients are needed to convert the wavelength-independent diameter to a uniform disk diameter for the specific band pass used by the interferometric instrument. The reduced precision due to employing a polynomial fit rather than a representation of the full spectrum is shown in Fig. 4.

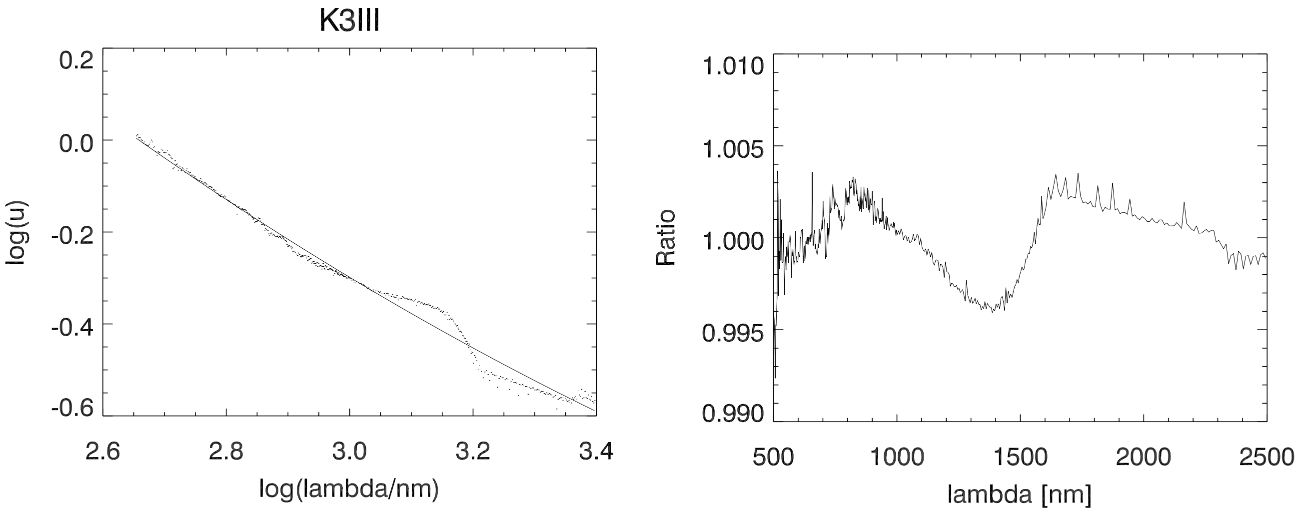

Figure 4. The plot on the left shows a quadratic fit to the logarithms of the linear limb darkening coefficients of a K3 giant. We show on the right that the systematic errors due to a second order polynomial fit to the limb darkening coefficients are always below 0.5% of the diameter.

5. CALIBRATORS IN THE COMMUNITY

How do the various interferometers handle calibrators? For the VLTI, ESO offers a web tool to select calibrators from underlying lists based on Verhoelst (PhD Thesis, for MIDI) and Borde[3] and Merand[4] (for AMBER). At NPOI, a list was compiled from the Bright Star Catalgue (Hoffleit) selecting against known double and spectroscopic binary stars and using the SB method to estimate diameters. PTI uses a list[2] based on diameters estimated from the effective temperature and bolometric luminosity, also selecting against known binaries. Bad calibrator lists are maintained in a more-or-less organized way by most interferometers.

6. FUTURE WORK

The working group relies upon contributions from the community, in return for faster progress towards larger and more reliable calibrator catalogs. It is therefore mandatory that tasks are defined to fit into this scheme without imposing unwanted services and resources. We have set up a web page at *http://www.eso.org/∼chummel/iau/iau.html* to document the work of the calibrator group.

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