NASSP Master's Project

Single Dish Flux Calibration

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1 Introduction

The receiving gain of a Radio Astronomy dish is a complex function of many variables that is impossible to model analytically and hence has to be measured so that the fluxes of astronomical targets can be put onto a common scale. This is typically done by observing a set of standard calibration targets for whom a reference flux has been defined.

However in practice, many sources on the sky (and in particular the bright ones used as calibrators) have extended structure on an angular scale not dissimilar to the primary beam of the dishes being used to measure it which significantly complicates the calibration scheme. Furthermore the fluxes of these standard candles also exhibit (slow) variations over time.

As a result of the flaws in this calibration scheme, it is difficult to rely on cross comparisons of flux measurements mad across multiple radio telescopes, which is increasingly a requirement in the move to multi-wavelength astronomy.

The HartRAO 26m antenna has the additional (now) unique problem of being mounted on an equatorial mount, such that the direction of the gravitational bending moment relative to the dish structure is a function of the look angle at the time of observation. Unlike an azimuth-elevation mounted dish, the gain function measured on one celestial source cannot be directly applied to another source as the gravitational bending of the dish is different. The gain of the 26m antenna is thus a subtle function of declination which cannot be directly measured.

HartRAO has recently commissioned a new 15m antenna on a azimuth elevation mount for which a simple elevation gain dependence is expected. Both receivers on this antenna have the same frequency coverage as their equivalents on the 26m antenna which should then allow for calibration transfer across sources by making use of contemporaneous observations on the two antennas after allowing for source structure effects.

2 This Project

The project would entail developing a calibration scheme for the 15m antenna and establishing the relative fluxes of the various sources used at HartRAO. Thereafter these flux values would be used to investigate various issues in the calibration scheme of the more sensitive 26m antenna with an eye to assessing the likely performance of the new 22GHz receiver on that telescope and in support of ongoing multi-wavelength flux monitoring efforts.

The project would involve learning how to schedule, analyse and interpret single dish flux measurements, which in turn are used as part of the calibration of both connected-element and very long baseline interferometers such as MeerKAT and the SKA.

References

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