Project title: **Non-imaging VLBI Astrometry and the inner Galaxy**

Project description:
We propose to work on non-imaging astrometric processing for VLBI, which will be relevant for the EHT, BeSSel and BAaDE projects in which I am involved. In particular we will develop a Bayesian framework that can fit source positions directly to VLBI phase reference observations.

The BAaDE project is detecting tens of thousands SiO masers associated with evolved stars in the inner Galaxy. In order to interpret this stellar population in terms of its dynamic history, we like to measure stellar orbits for a subset of these. From our pilot observations it has become clear that standard VLBI phase referencing for these targets is very challenging and will require new methods. We have obtained encouraging results from a first attempt to search for astrometric solutions using brute force MCMC sampling. Similarly, the BeSSel project is mapping water and methanol masers across the Galaxy and has been used to measure the rotation curve and location of the spiral arms. The routines to distil astrometry from the existing observations are complex and require much human intervention.

The Event Horizon Telescope is most known for resolving the image of M87, but the more interesting target is SgrA*, where the precise mass and distance are known from tracing stellar orbits in the IR. It is expected that there will be substantial synergy between the IR and millimetre projects in revealing the nature of the Black Hole in the Galactic centre. For example, the black hole's spin is still not constrained. Progress can be made by precisely aligning the optical and radio measurements. Possibly this can be done with astrometry of SiO maser bearing stars that are bright in the IR and at 86 GHz. These objects can also be used to probed the extend of the enigmatic interstellar scattering towards SgrA.

In the context of the EHT, quite a number of frameworks have been developed to fit complex models to VLBI data, simultaneous with telescope calibrations. Learning from these methods the student will work towards adapting these techniques for astrometry. It will involve understanding the complexity of (spectral line) VLBI astrometry and the calibration issues. New functionality will need to be implemented that can determine very precise source positions while simultaneously determining the posterior distributions of the telescope calibration factors. We have made progress with such approaches, but they have not been applied to astrometric problems yet.

Supervisor: Prof Huib van Langevelde, primarily affiliated with JIVE, Dwingeloo and director of the global Event Horizon Telescope Consortium

Requirements: A sound background in statistical methods is required and knowledge of radio interferometry would be an advantage.

Applications:
To apply for this vacancy, send an email to langevelde@jive.eu quoting the project title. Please make a CV and transcripts available of Bachelor and Master results. Preferably a copy of your (draft) Master thesis and names of 2 possible referees.