AMBER+FINITO+UT Science Demonstration Proposal

How many of the RV-detected exoplanets are truly "planetary"? Using AMBER+FINITO+UTs to determine the true mass of these companions

Investigators	Institute	EMAIL
Gil, C	ESO, Chile	cgil@eso.org
Tata, R	University of Central Florida, USA	tata@physics.ucf.edu
Martioli, E	Instituto Nacional de Pesquisas Espaciais, Brazil	eder@das.inpe.br
Kanaan, S	Observatoire de la Cte d'Azur, France	samer.kanaan@obs-azur.fr
Martin , E. L.	Instituto de Astrofisica de Canarias, Spain	ege@iac.es
Benedict, F	University of Texas at Austin, USA	fritz@astro.as.utexas.edu
McArthur, B	University of Texas at Austin, USA	mca@barney.as.utexas.edu

Abstract:

As a first attempt to obtain the true mass and inclination of a radial velocity detected companion using optical interferometry, we want to observe HD33636 ($Kmag = 5.57$) using AMBER+FINITO. A radial velocity (RV) companion $msin(i)= 9.28M_{\rm J}$ was detected around HD33636 (Vogt et. al. 2002) . Studies using HST astrometry revealed the true mass of the companion to be $142M_{\rm J}$ (Bean et. al. 2007). Using interferometry, we will confirm the true mass of this companion and also demonstrate a method for using AMBER+FINITO to provide either the true mass or an upper limit on the true mass (if no signal detected) of the RV-detected exoplanet companions. Once established, this technique can be used to quickly and effectively filter out radial velocity exoplanets for follow-up astrometric studies (PRIMA, SIM, etc.) to determine the true mass.

Scientific Case:

In the past decade, radial velocity surveys have detected over 200 extrasolar planets with masses $Msin(i) < 13M_J$ (where M_J is the Jupiter mass). Even though the radial velocity method provides initial detection, important orbital information and an estimate of the minimum mass, the true mass of the companions depends on the inclination angle. For this reason, high precision astrometry is required to further constrain the orbit, obtain the inclination angle, and determine the true mass of the companions. High precision and long time baselines are two challenging and time consuming factors for using astrometry. Follow-up astrometry to detect the reflex motion due to very low mass companions requires an outstanding astrometric precision ($\sim 1mas$) for a time span of the order of the orbital period. HD33636, with an orbital period of 2117 days, therefore required 1.2 years of HST FGS astrometric observations to determine the orbit of its companion.

The advantage of using optical interferometry over high precision astrometry is that we can constrain the inclination angle of the binary and measure its true mass by observing it during less than half a night as opposed to 1 year. HD33636 is an ideal target for the AMBER+FINITO Science Verification because it not only pushes the limits of these instruments, but also can prove the efficiency of interferometric techniques over conventional ones. We propose to observe HD33636 using AMBER+FINITO+UTs in the low resolution mode using fringe tracking since H<7 for our target. The documented precision of 9% in visibility measurements and 1% in closure phase measurements is ideal for such direct determination of the flux-ratio and angular separation of binary systems. HD33636 is located at 28.7 pc, has a binary separation of 0.42 AU and the magnitude difference between the primary and the secondary is ΔK=4.0. Using ASPRO (JMMC tool) and VisCalc (ESO tool), we have modeled visibilities and closure phase signals for different inclinations during the observing epoch for HD33636 and have estimated an absolute visibility of about 0.9 and a closure phase amplitude of about 5°. The sinusoidal behaviour of the visibillity and closure phase as a function of the projected baselines will allow us to determine unique information on our binary system.

With our proposed technique (along with RV determined orbital parameters) , we expect to be able to detect both the unknown orbital parameters: **the inclination** and **the position angle of the ascending node**, only by obtaining 3 visibility points.

The immediate objectives of this project are :
• To confirm the mass and the orbital parameters of the companion of HD33636.
• To investigate the differential phase signal and look for any spectral signatures of the companion.
• To demonstrate and evaluate the use of AMBER+FINITO+UTs for similar studies which may require the measurement of very small visibility and closure phase signals.

The projected objectives of this project are :
• Once the use of AMBER+FINITO+UTs/ATs is established to obtain/estimate the true mass, this method can be used to effectively filter out "true" exoplanet candidates for future astrometric programs like PRIMA and SIM.
• Some of these exoplanet companions may turn out to be brown dwarfs (true mass between $13M_{\rm J}$ and $72M_{\rm J}$). This will help us to have a better understanding of the brown dwarf desert (if real).

Calibration strategy:

Our main goals are to measure the absolute closure phase and absolute visibilities. For these reasons, we would like to use the smallest DIT possible and use three CAL/SCI pairs in a row in order to calibrate the transfer function. If 3 measurements are not possible, we would like to have a minimum of 2 pairs of CAL/SCI.

Targets and number of visibility measurements

Target	**RA**	**DEC**	**V** mag	**H** mag	**K** mag	**Size** (mas)	**Vis.**	**Mode**	**# of** Vis.
HD 33636	05 11 46.4490	+04 24 12.742	7.06	5.63	5.57	0.33	0.99/0.94/0.93	LR	3

Time Justification:

We are requesting a total of 3 hours and 30 minutes of observations with AMBER+FINITO. According to the latest AMBER User Manual, it takes 70 minutes to observe one calibrated visibility point with the UTs. Since we need 3 calibrated points: 3x70min=210min= 3h30min.