Practice Work Session P1 (2h)

From models to visibilities

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Abstract

The following exercices are aimed at getting trained to the link between the object intensity distribution and the corresponding visibility curves. They are intended to be the practical application of the "Visibility modeling" Tutorial. This practical session is meant to be done with the ASPRO software and hand-made uv tables.

Practical considerations.

To start ASPRO, in the home directory just type "`$ aspro`". We will use for this session the *Full Aspro Interface* in the *Choose ...* menu. ASPRO is able to do many things but this session will focus on the *MODEL/FIT* part.

All the exercises should be done assuming a simple yet unrealistic (u, v) coverage. Synthetic (u, v) tables simulating perfect (u, v) coverages are provided for use: `strip-[J,H,K,N]-[000,..,170].uvt`, where the number `xxx` is the projected baseline angle in degrees.

Exercise 1: Measuring a diameter.

Given a star with a 2 mas photospheric radius use the model function to plot the visibility versus the projected baseline length (baseline `radius`). Use the *MODEL/FIT.UV Plots & Source Modeling* menu. At what baseline does the visibility become equal to zero ? Use this number to evaluate the disk diameter.

Exercise 2: Binary.

Display the visibility and phase as a function of projected baseline (`strip-K-60`) of a binary with unresolved components with 4 mas separation, flux ratio of 1 and position angle of 30 degrees. Do the same thing with separation of 12 mas. Comment on the result.

Using the previous model now vary the flux ratio from 1 to 1e-6. Comment on how the dynamic range requirement to detect the companion translates into visibility and phase constraints ? Would the phase alone be sufficient to constraint binary parameters ?

Exercise 3: Disk.

Display the visibility curve of a disk which is assumed to have an elliptical gaussian shape (`E_GAUSS`). Use the minor and major axes (parameters 4 & 5) to simulate an inclination. The display should be done for several PAs (`strip-*-(0,30,45,60,90)`). Comment on how the asymetry induced by the inclination changes the visibility function at a given projected angle.

Exercice 4: Model confusion and accuracy.

Use the model function to compute the visibility of a star with a uniform disk brightness distribution (2 mas radius), circular gaussian disk (1.2 mas radius) and binary (flux ratio 1, 1 mas separation, 45° PA) with `strip-K-60` . Compare their visibilities at 100 m in the K band. How can we distinguish between these various models? What about measurements at 200 m. What do you conclude?

Construct a 2-component model in which a central unresolved star (`POINT`) is surrounded by an inclined extended structure. You can use an elliptical gaussian distribution (`E_GAUSS`) for that purpose (minor and major axes in the range 0.5 to 15 mas).

Try two scenarii:

- an extended source easely resolvable but with a flux contribution much smaller than the star;
- an extended source smaller but with a larger flux contribution.

What are the best baseline lengths to estimate the size and relative flux contributions with an interferometer?

Exercise 6: Choosing the right baselines.

In order to determine the parts of the (u, v) plane which constraint the model most, one can make use of the first derivative of the visibility with respect to a given parameter. Choose a uniform disk model. What is the most constraining part in the (u, v) plane? For this exercise, in `UV EXPLORE` panel, use `V` vs `U`, check the `underplot model image` option, and choose the appropriate derivative in the `plot what...` line.

Exercise 7: An unknown astrophysical object.

Load the fits table `fudisk-N.fits` corresponding to the simulation of a certain type of astrophysical object (here a disk around an FU Orionis object) using *OTHER/Display a GDF or FITS image* menu. If the color scale is not appropriate, check the *Optional parameters* button and select another color scale. Notice what is the contrast of the object (NB: the angular units are in radians).
Compute the visibility of the model in the N-Band with *MODEL/ FIT.UV Plots & Source Modeling/USE HOMEMADE MODEL*. To do so, select the appropriate grid `strip-N-60` in the *Input Information* menu. Use `UV EXPLORE` to plot the visibility amplitude versus the spatial frequency radius.
Repeat these operations in the K band, then the H and J ones. Compare the visibility profiles. Conclude on the resolution of the object at these different wavelengths.

Exercise 8: Play with spectral variations, closure phases, etc.

Using a given model of a binary star (γ^2 Vel, file gammaVelModelForAspro.fits), try to plot visibility and closure phases as a function of wavelength (see the "OTHER ... Export UV table as OI fits" and "OTHER ... OI fits file explorer" menus). Compare with what you would get with an ASPRO model of one gaussian and one uniform disk of diameters 0.5 mas, a separation of 3.65 mas and an angle of 75 degrees. What do you conclude ?