Practice Work Session #1 (3h)
From models to visibilities

EuroWinter School
Observing with the Very Large Telescope Interferometer

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Objectives

The following exercices are aimed to get trained to the link between the object intensity distribution and the corresponding visibility curves. All the exercises should be done assuming a perfect (u,v) coverage. Synthetic (u,v) tables simulating perfect (u,v) coverages are provided for use by the ASPRO software: `grid-[J,H,K,N].uvt`, `strip-[J,H,K,N]-[0,..,90]deg.uvt`.

To start ASPRO, follow the instructions:

- `login: user`
- `password: obsvlti`
- open an X-terminal

That's all!...

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 becomes 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-60deg`) 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 axis (parameters 4 & 5) to simulate an inclination. The display should be done for several PAs (`strip-*-(0,30,45,60,90)deg`). Comment on how the asymetry induced by the inclination translates into the visibility baseline at a given projected angle.

Exercise 4: Model confusion and accuracy.

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

Exercise 5: Unresolved star + extended structure.

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 axis in the range 0.5 to 15 mas).

We 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 most the model, 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, see seminar by Berger) 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-60deg` 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 H and J ones. Compare the visibility profiles. Conclude on the resolution of the object at these different wavelengths.