

## Anleitung: AstrolmageJ - Make asteroid parallax visible

### Make asteroid parallax visible (Version 1.1)

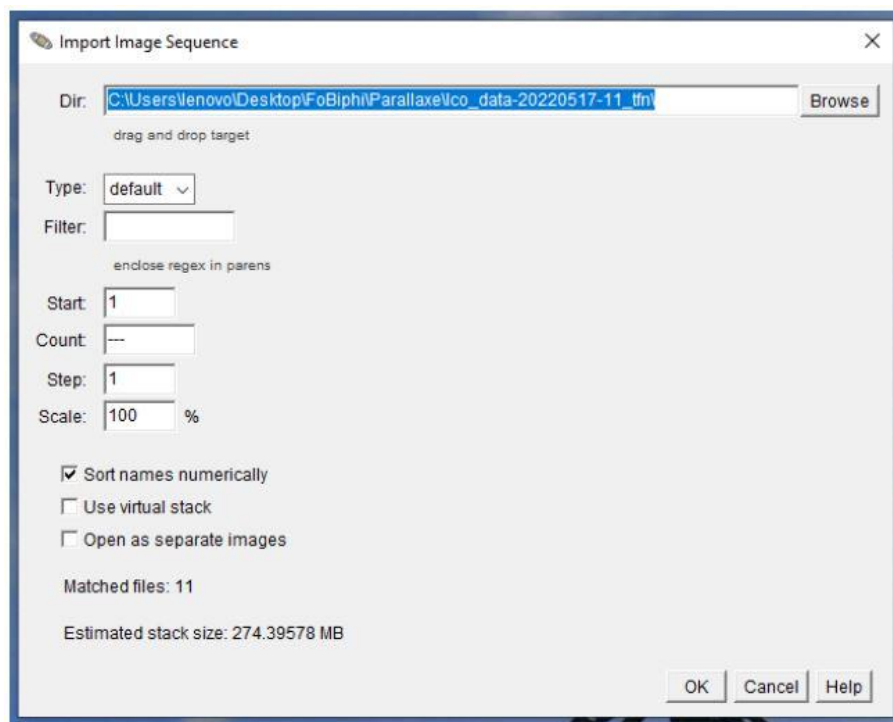
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#### 1. Download

- a. Download the images of PHA 7335 on your computer :
  - Cerro Tololo/Chile : <https://observe.lco.global/requests/2897700>
  - Teide/Tenerife : <https://observe.lco.global/requests/2897699>
- b. Perhaps write down now which recordings were made relatively simultaneously!
- c. Extract the ZIP-folders.

#### 2. Initial assessment and orientation

- a. Load both sequences in AstrolmageJ (AIJ) :  
AIJ-Menu : **File** → **Import** → **Image Sequence ...**



Select folder and confirm with [OK].

- b. Start the animations!

#### **Understanding :**

There are fixed stars and moving objects, e.g. Asteroid 7335.

PHA (Potentially Hazardous Asteroid) 7335 is so close that it shows a clear parallax (thumb jump) when viewed simultaneously from Teide (tfn) and Cerro Tololo (lsc).

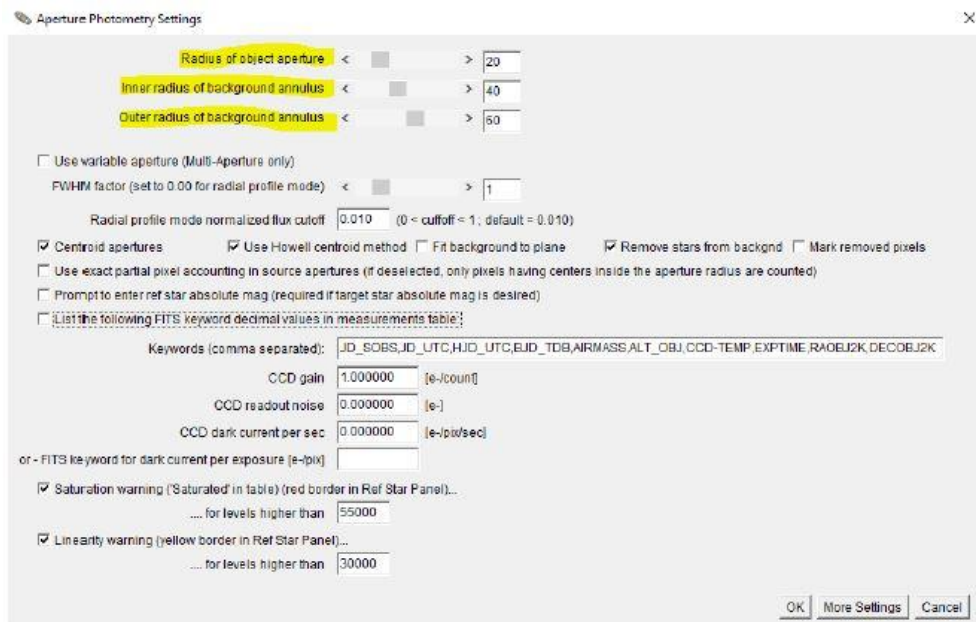
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## Questions :

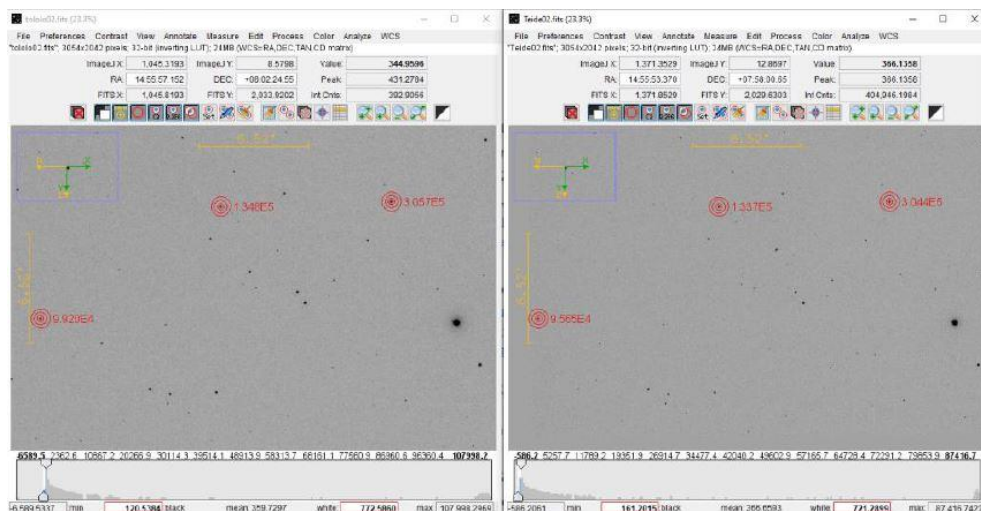
- What is an asteroid?
- What is a NEO?
- When is an asteroid called a PHA?

## 3. Alignment of the images

- Close both stack windows.
- Load a picture of Teide (tfn) and a picture of Cerro Tololo (lcs), that is as close to the same time as possible :  
AIJ-Menu : **File** → **Open**
- Select the icon ... in the AIJ-Menu with right mouse click und take the following settings:

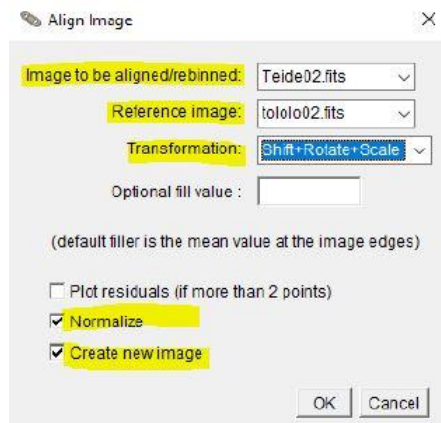


- Select at least three of the same stars in the same order in each window.



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- e. Align the fixed stars in the Teide image with the fixed stars in the Tololo image :  
AIJ-Menu : **Plugins** → **Astronomy** → **Align Image**



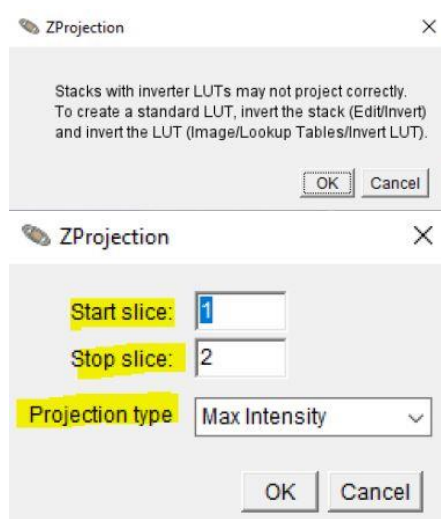
- f. Delete the old Teide image!
- g. Save both images as fits files "Teide" and "Tololo" :  
AIJ-Menu : **File** → **Save As** → **FITS ...**
- h. Close AIJ ! ( to reset the program settings! )

### 4. "Thumb jump" :

- a. Reopen AIJ and load the two saved fits files.
- b. Push both files into a stack :  
AIJ-Menu : **Image** → **Stacks** → **Images to Stack**
- c. When the animation starts, the "thumb jump" can be seen.

### 5. Measurement of parallax :

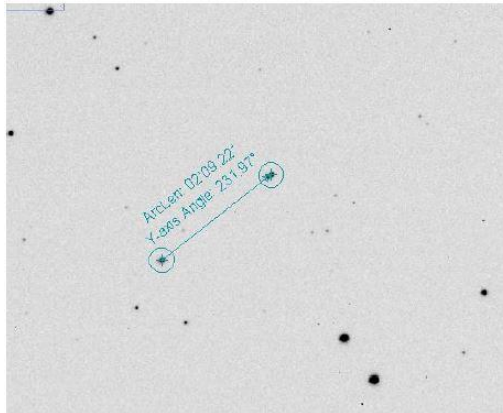
- a. Create a composite :  
AIJ-Menu : **Image** → **Stacks** → **Z Project**



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b. Parallax :

Hold down the middle mouse button and draw a connecting line between the asteroid positions :



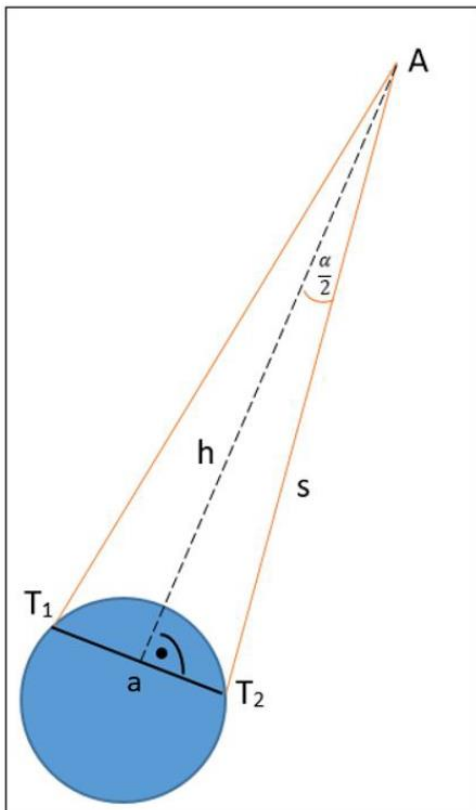
### Understanding :

The parallax angle is easily measurable and is  $00^{\circ} 02' 09.22'' = 0.03589387^{\circ}$ .

### Questions :

- How could one estimate the measurement error?
- What information does the Y-axis angle give us:  $231.97^{\circ}$ ?

6. Distance between earth and asteroid (a rough mathematical estimate) :



Assuming that the triangle  $T_1T_2A$  (Telescope\_1, Telescope\_2, Asteroid) in good approximation is isosceles and the baseline  $a$  between  $T_1$  (Teide) and  $T_2$  (Cerro Tololo) is 8032 km, then you get with the tangent or sine-function:

For the height  $h$  of the triangle  
 $h = 0.5 \cdot a / \tan(\alpha/2) = 12821123\text{km} = 0.0857\text{AU}$

or for the thighs  $s$   
 $s = 0.5 \cdot a / \sin(\alpha/2) = 12821123\text{km} = 0.0857\text{AU}$ .

The MPC states 0.085AU for the distance  $s$  on this day.

Source : <https://www.minorplanetcenter.net/iau/MPEph/MPEph.html>

This means that the rough estimate agrees with the MPC data with a deviation of approx. 1% match.

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### 7. Questions :

- How good is this rough estimate? How can one estimate the errors?
- Is the assumption “isosceles triangle” justified here?
- In which constellations is the triangle  $T_1T_2A$  very far away from an isosceles triangle? Can situations like this really happen here?
- How could one calculate the distance between the telescopes using trigonometry in class 9? This contribution to the mathematical understanding of geography (geographical longitude and latitude) can be useful as an interdisciplinary aspect.

### 8. Further examples :

- a. **2100 Ra-Shalom** is an asteroid and near-Earth object of the Aten group on an eccentric orbit in the inner Solar System. It was discovered on 10 September 1978, by American astronomer Eleanor Frances Helin at the Palomar Observatory, California. Named by the discoverer for the Egyptian sun-god Ra, who symbolizes enlightenment and peace, and for Shalom, the traditional Hebrew greeting meaning peace. This name is chosen to commemorate the Camp David mid-East peace conference, at which time this unusual body was found. May it stand as a symbol for the universal hope for peace.

We observed Ra-Shalom on 08/13/2022 at about 10:20UT simultaneously from Mt.Locke/Texas and from Haleakala/Hawaii:

Mt.Locke/Texas : <https://observe.lco.global/requests/2971695>

Haleakala/Hawaii : <https://observe.lco.global/requests/2971696>

Distance between Mt.Locke and Haleakala:  $a = 5154$  km

Make the parallax visible!

What was the name of **Ra-Shalom** on Earth on 08/13/2022?

- b. **3752 Camillo** is an inclined asteroid, classified as near-Earth object of the Apollo group, approximately 2.3 kilometers (1.4 miles) in diameter. It was discovered on 15 August 1985, by astronomers Eleanor Frances Helin and Maria Antonella Barucci using a 0.9-metre (35 in) telescope at the CERGA Observatory in Caussols, France. Lightcurve studies by Petr Pravec in 1998 suggest that the assumed S-type asteroid has an elongated shape and a longer-than average rotation period of 38 hours. Named for the young son of Turno, king of the earliest Romans. The name also honors the son of the second discoverer.

We observed Camillo on 08/17/2022 at about 03:00UT simultaneously from Teide/Tenerife and from Cerro Tololo/Chile:

Teide/Tenerife : <https://observe.lco.global/requests/2974558>

Cerro Tololo/Chile : <https://observe.lco.global/requests/2974560>

Distance between Teide and Cerro Tololo:  $a = 8031$  km

Make the parallax visible!

What was the name of **Camillo** on Earth on 08/17/2022?