

De ALMA telescoop onthult het ontstaan van planeten



Michiel Hogerheijde
Universiteit Leiden
Universiteit van Amsterdam



EUROPEAN ARC
ALMA Regional Centre || Allegro

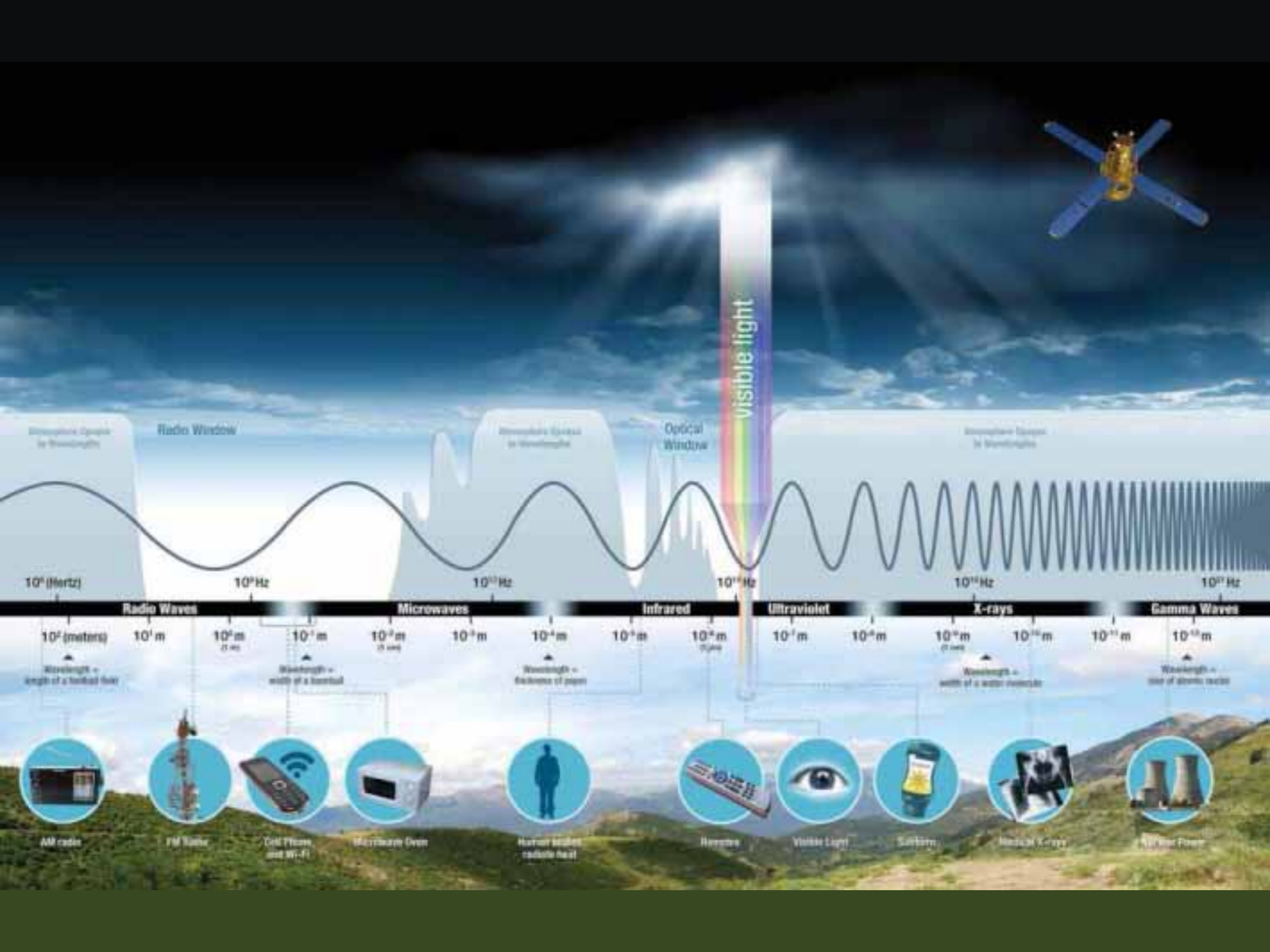


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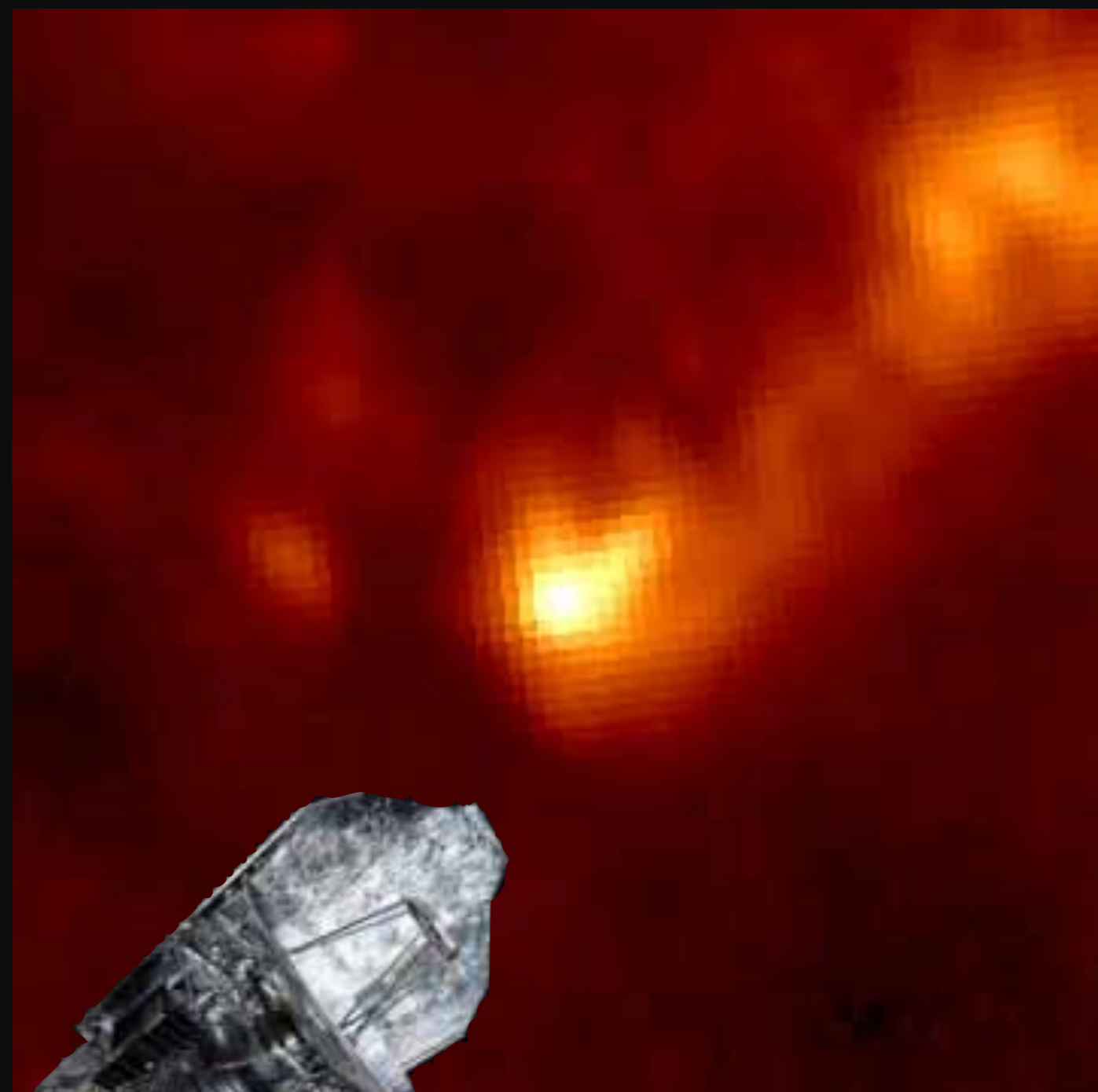
UNIVERSITEIT VAN AMSTERDAM







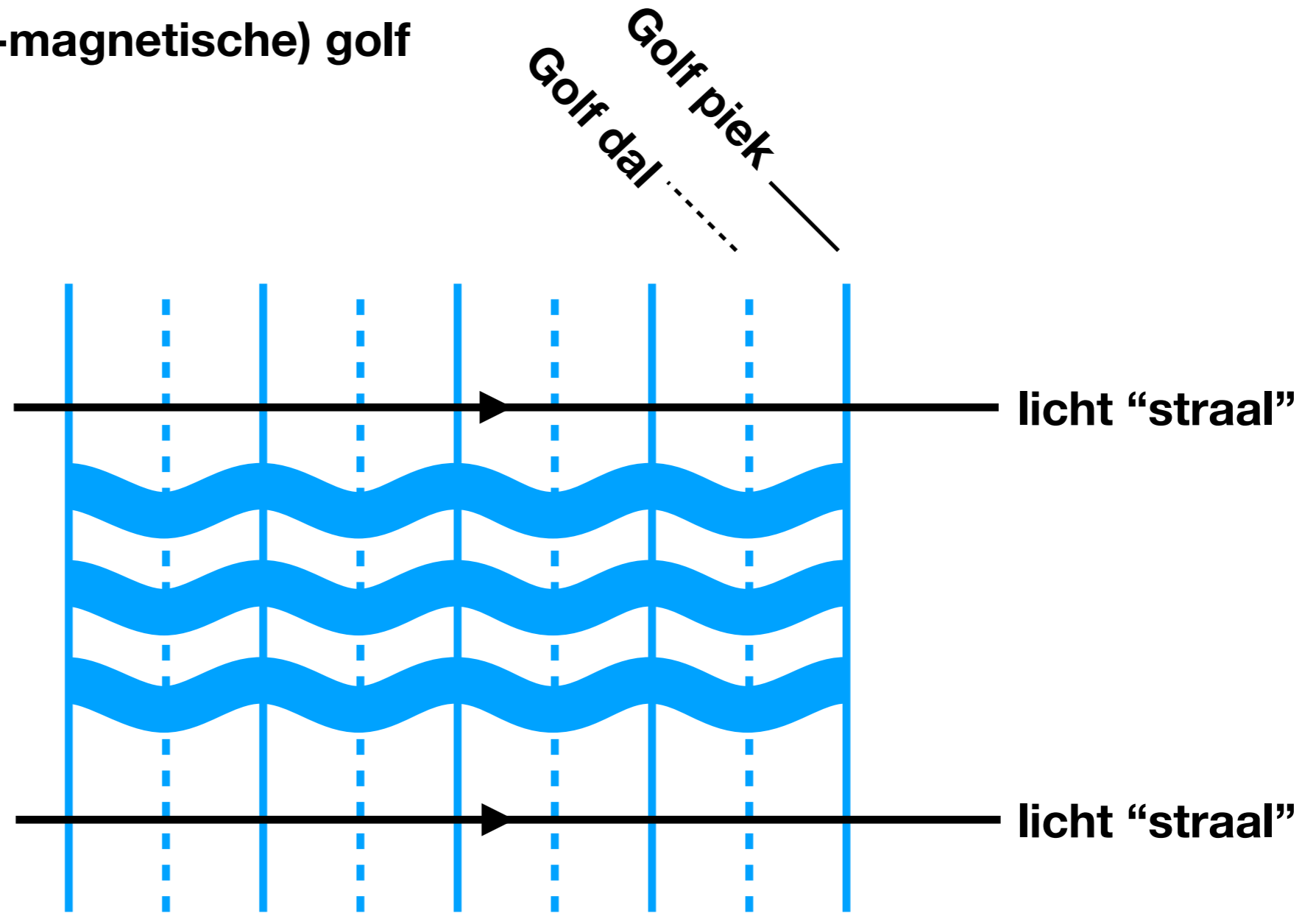
Hubble Space Telescope



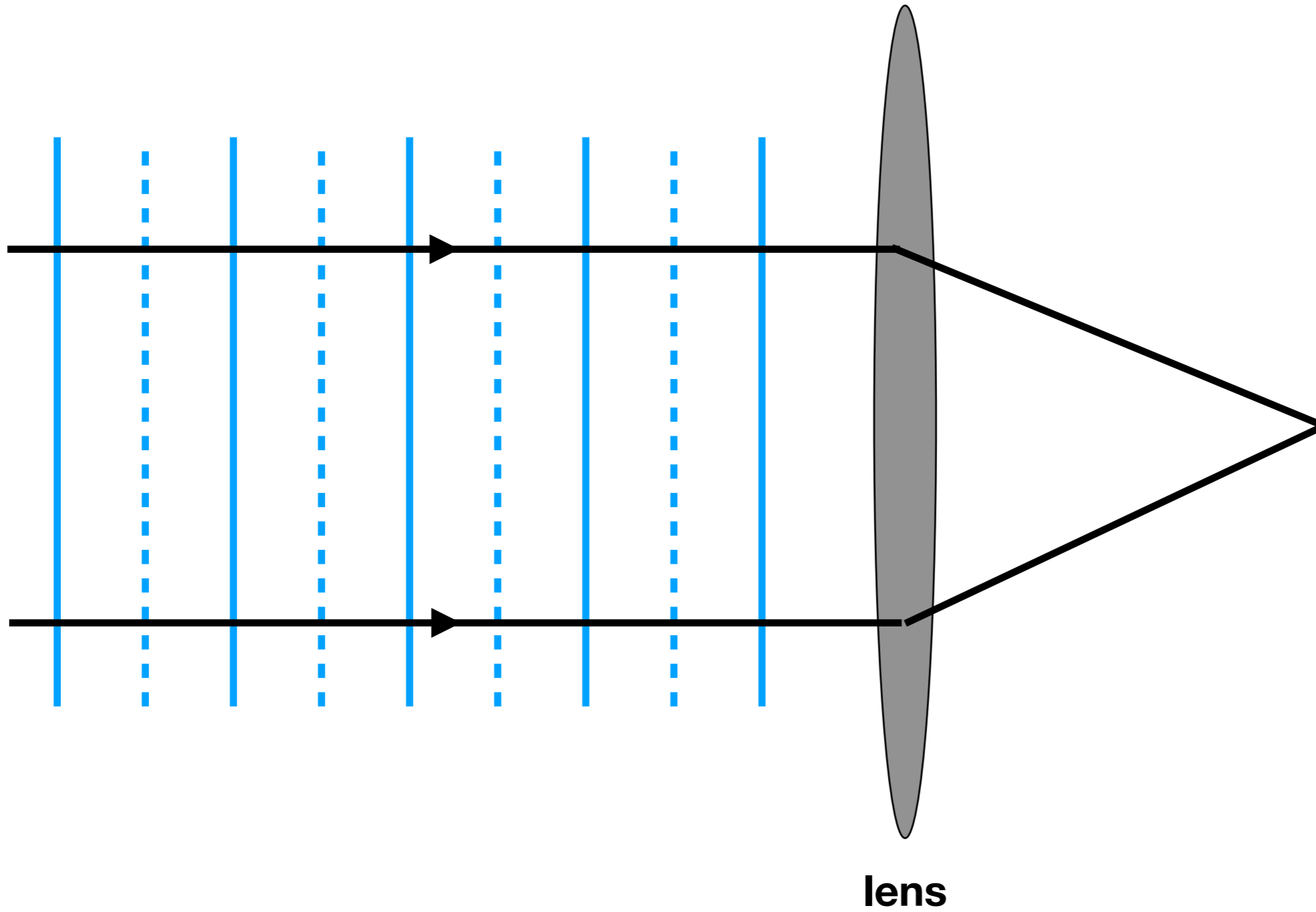
Herschel Space Observatory



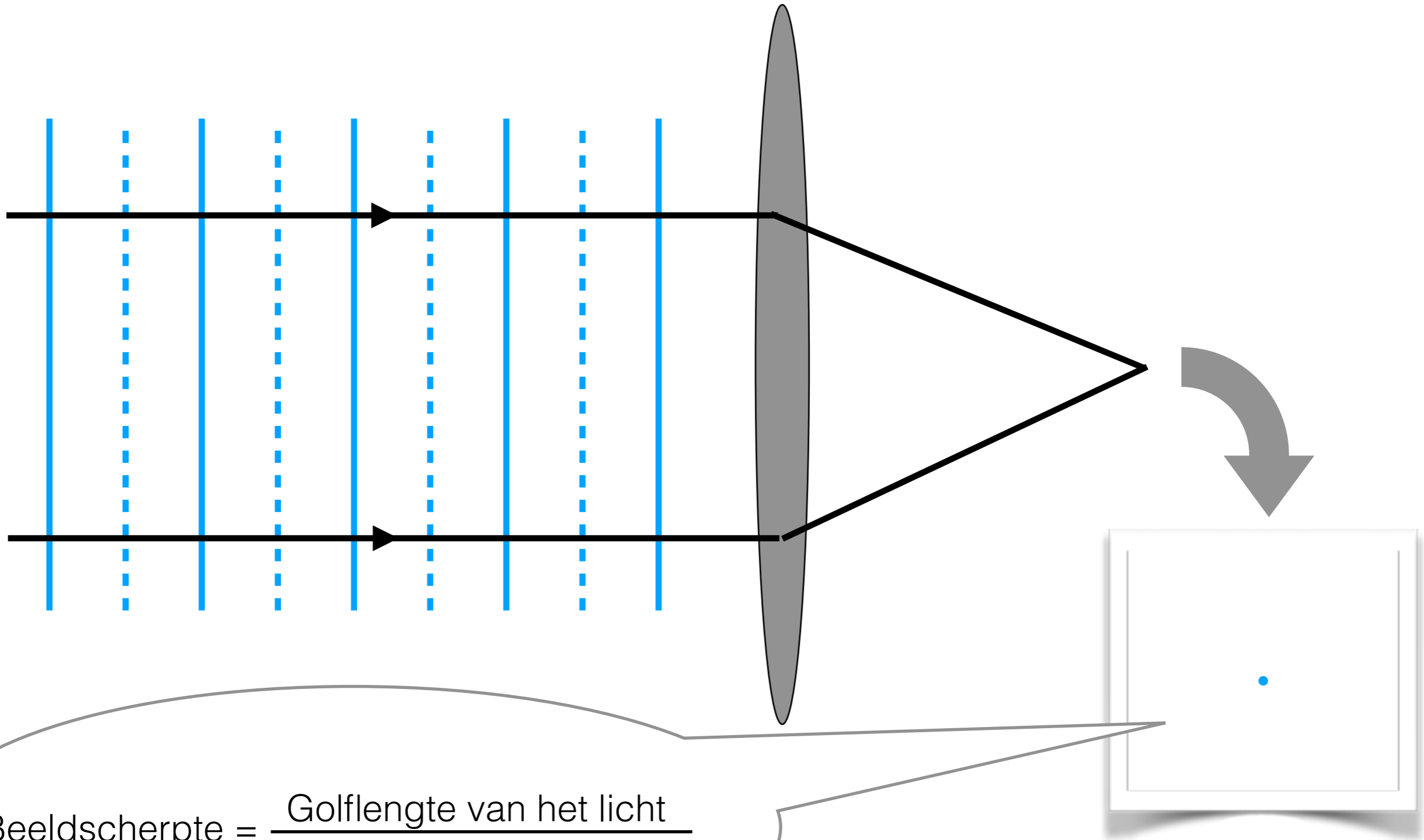
Licht is een (electro-magnetische) golf



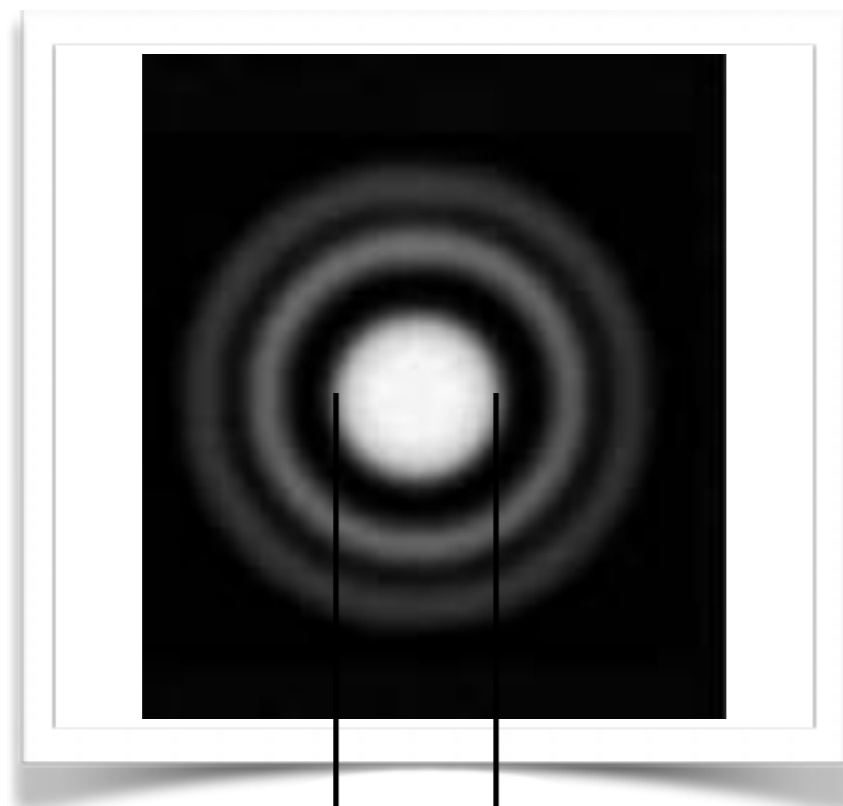
Een lens concentreert het licht uit één richting in één punt → afbeelding



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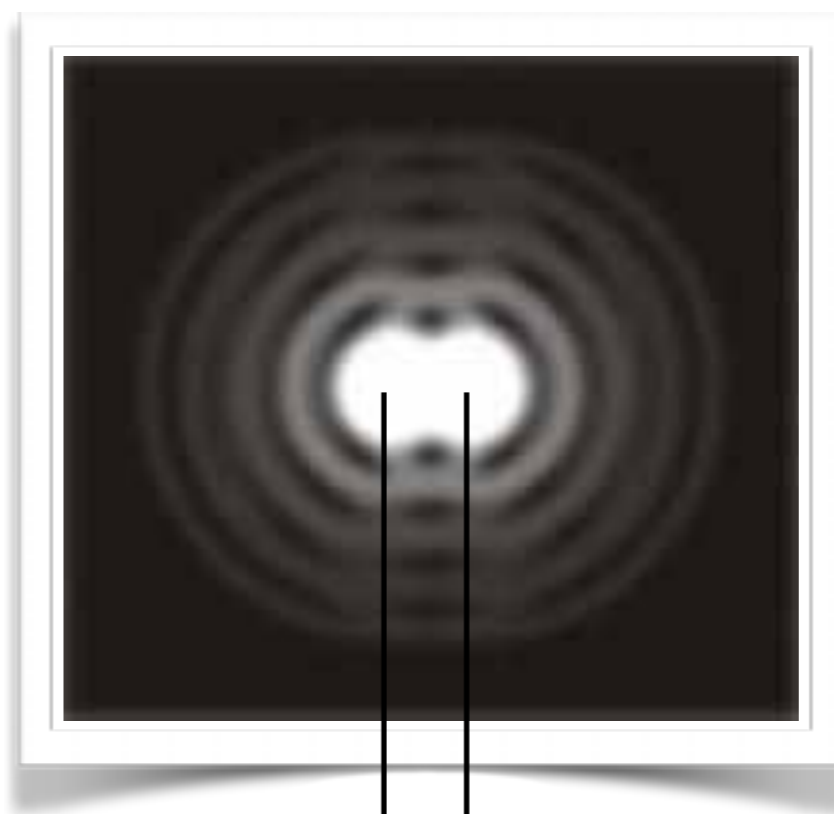
$$\text{Beeldscherpte} = \frac{\text{Golflengte van het licht}}{\text{Diameter van de lens}}$$



Afbeelding van 1 object

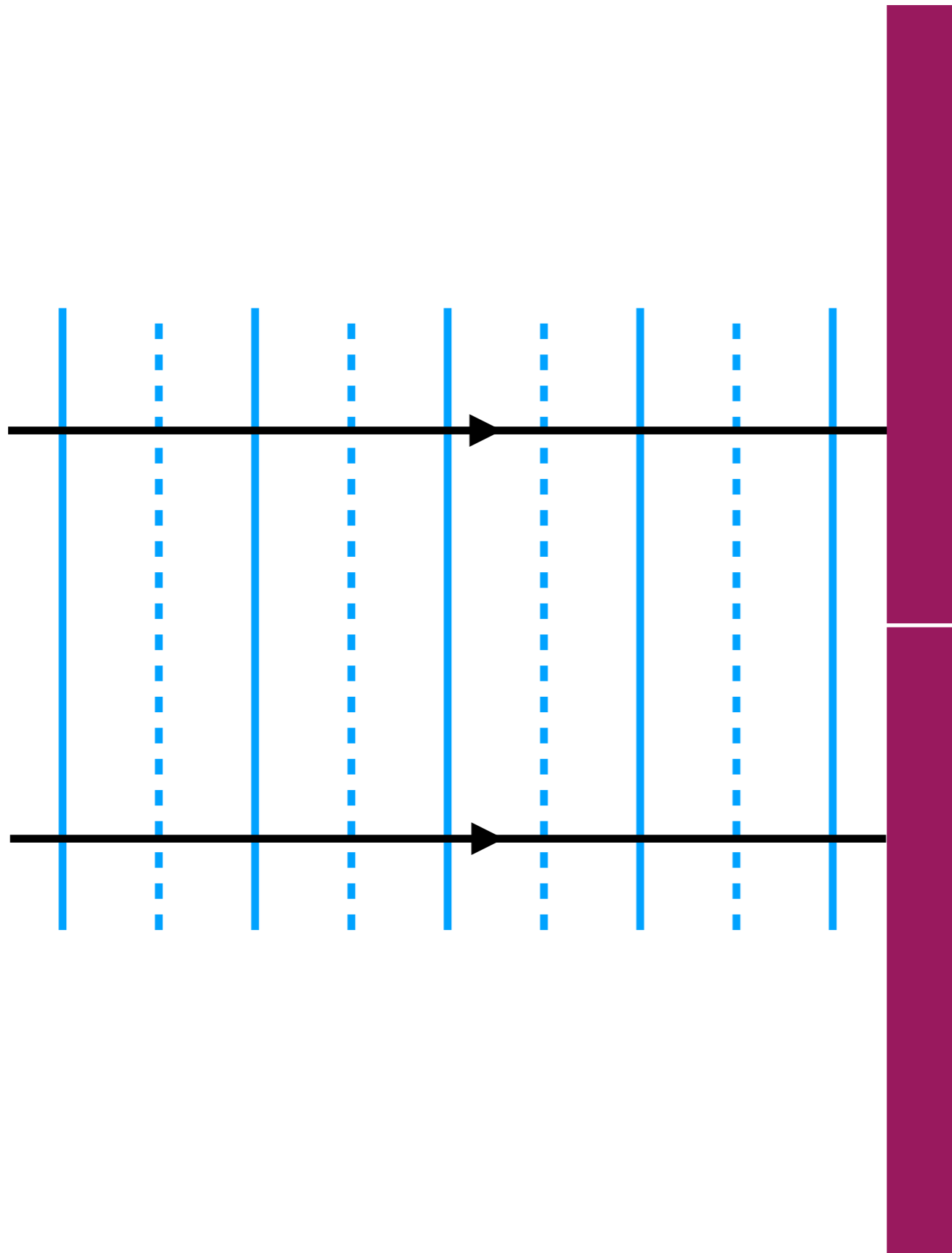
golflengte/ D

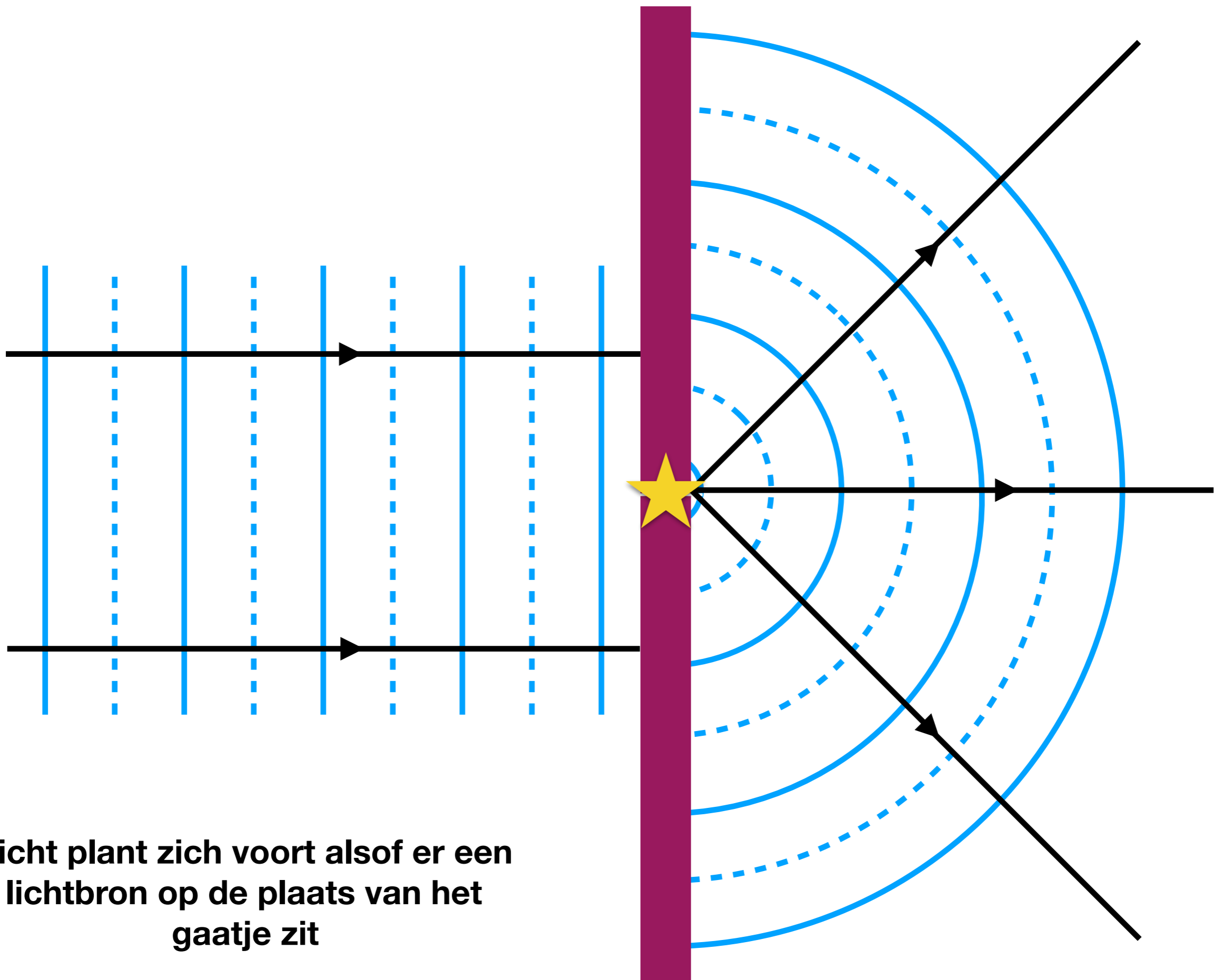
Afbeelding van 2 objecten.
Te onderscheiden tot op
golflengte / D



golflengte/ D

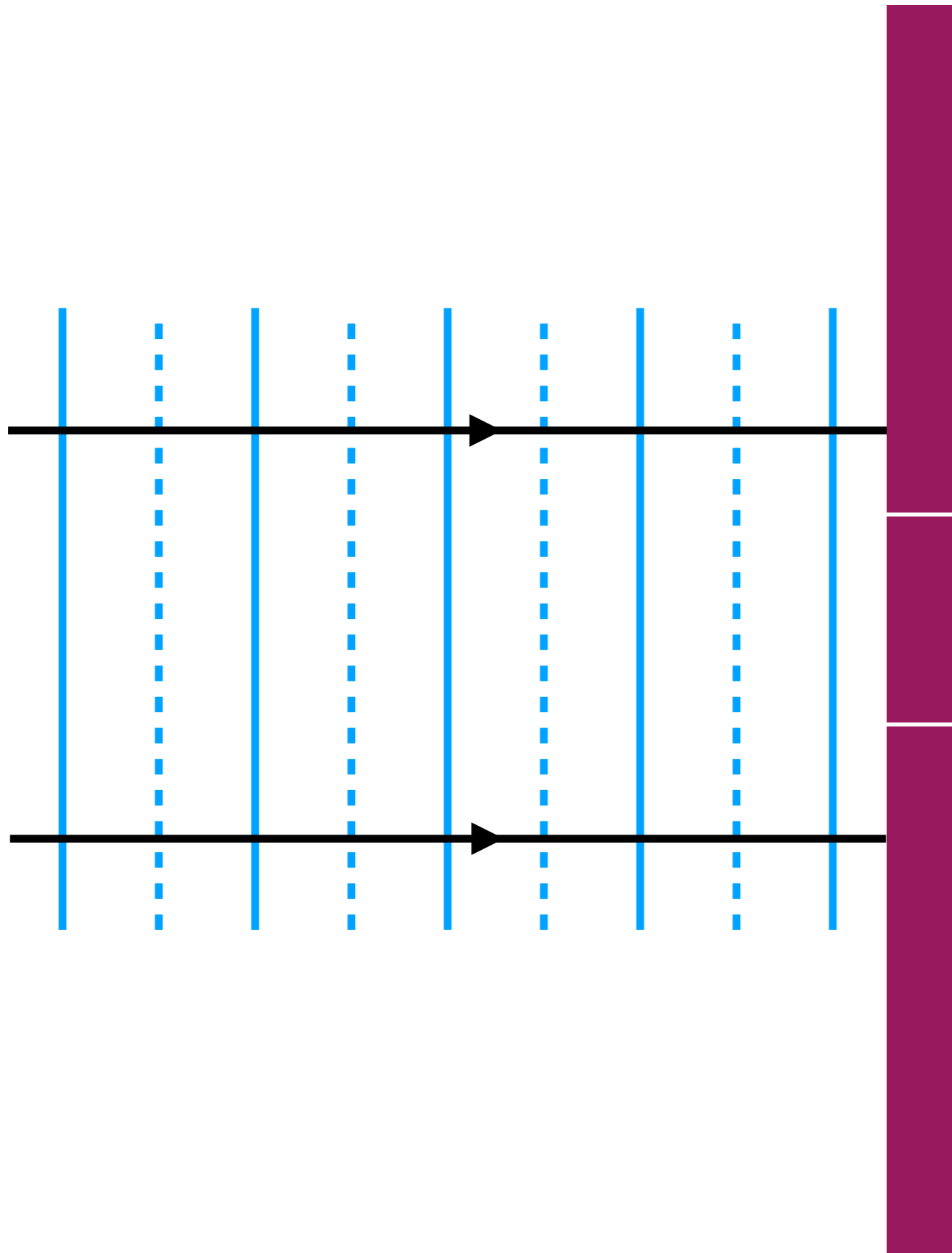
Scherf met klein gaatje

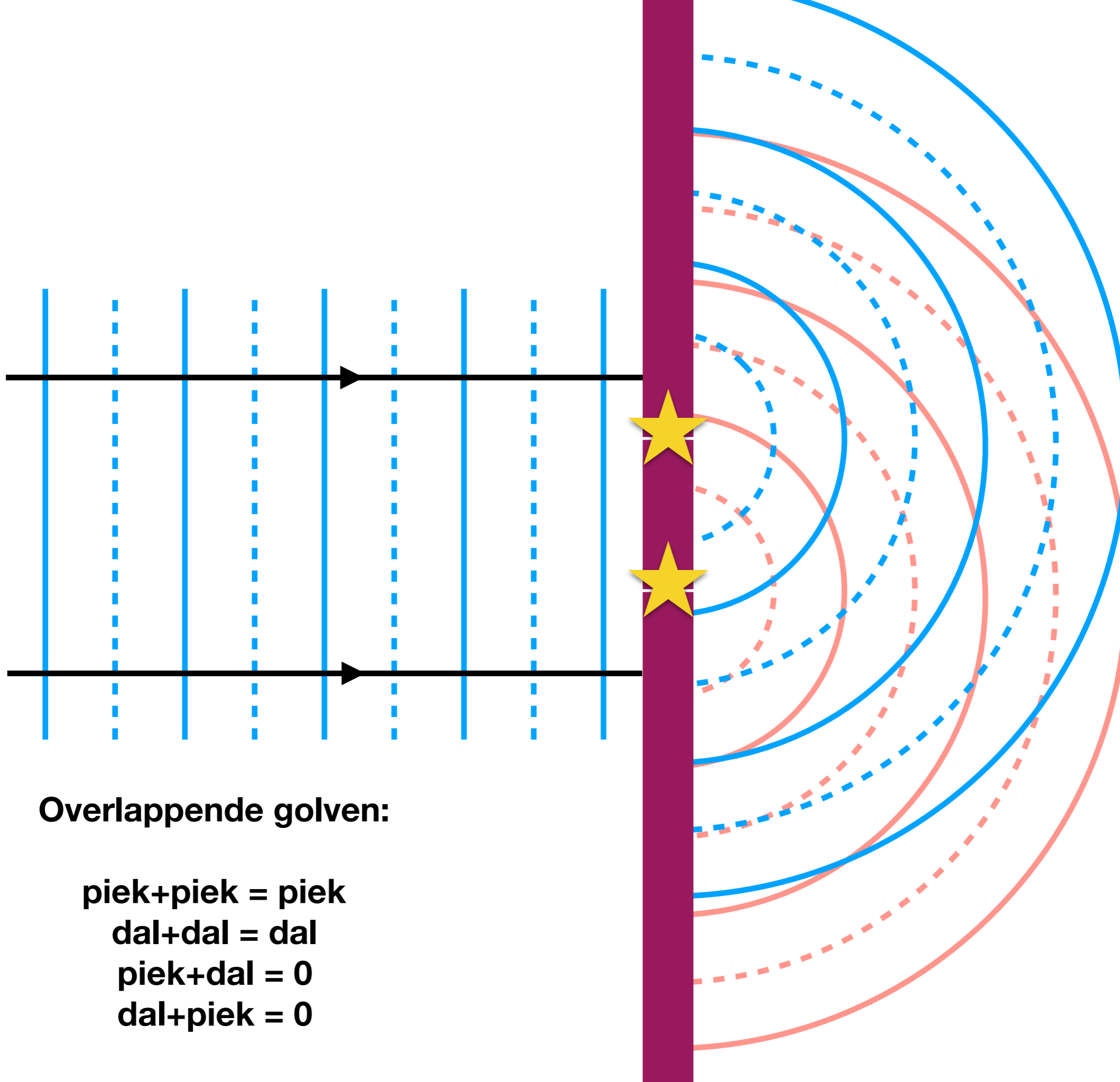




Licht plant zich voort alsof er een lichtbron op de plaats van het gaatje zit

**Wat gebeurt er als er twee gaatjes
in het scherm zitten?**





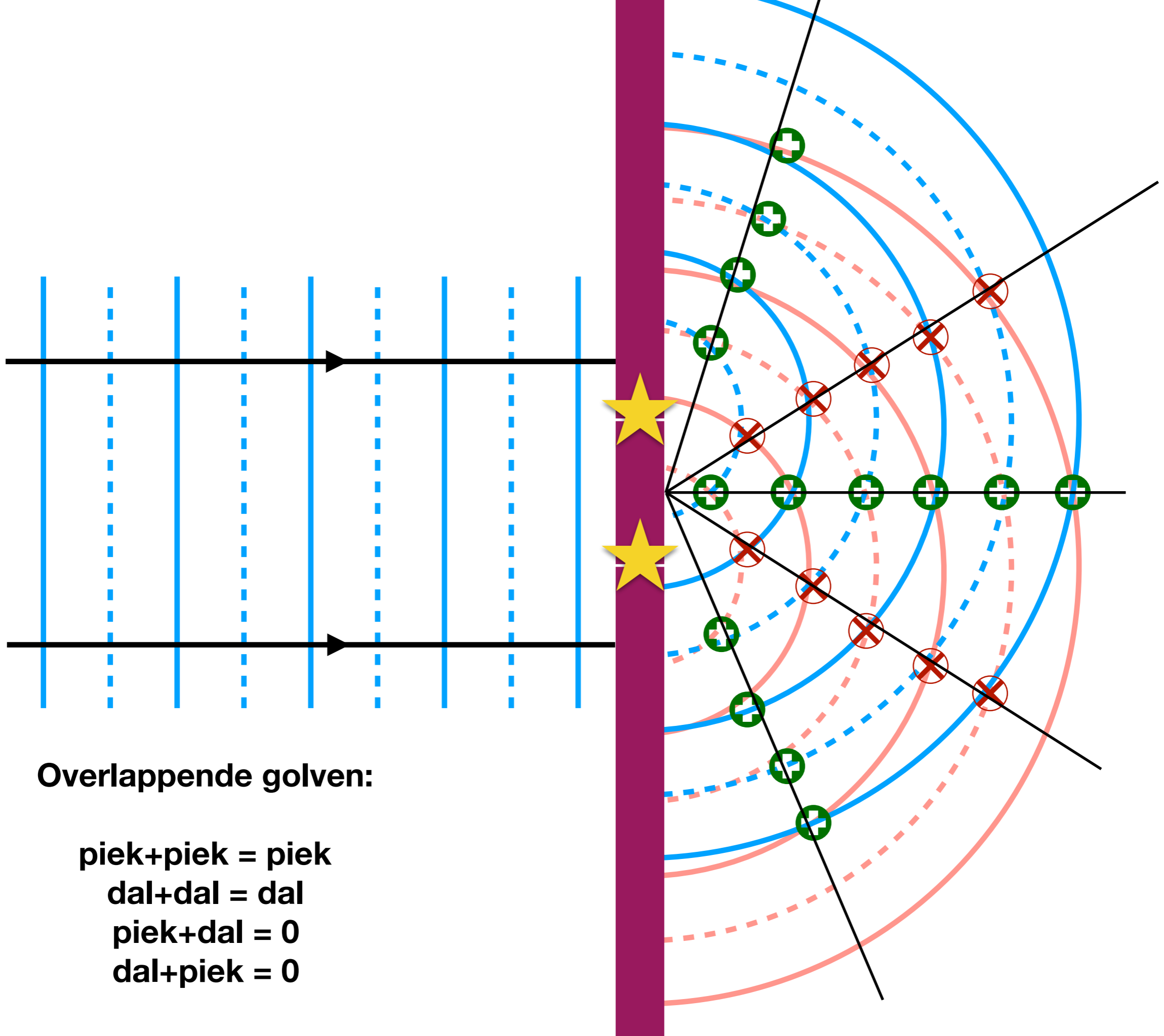
Overlappende golven:

piek+piek = piek

dal+dal = dal

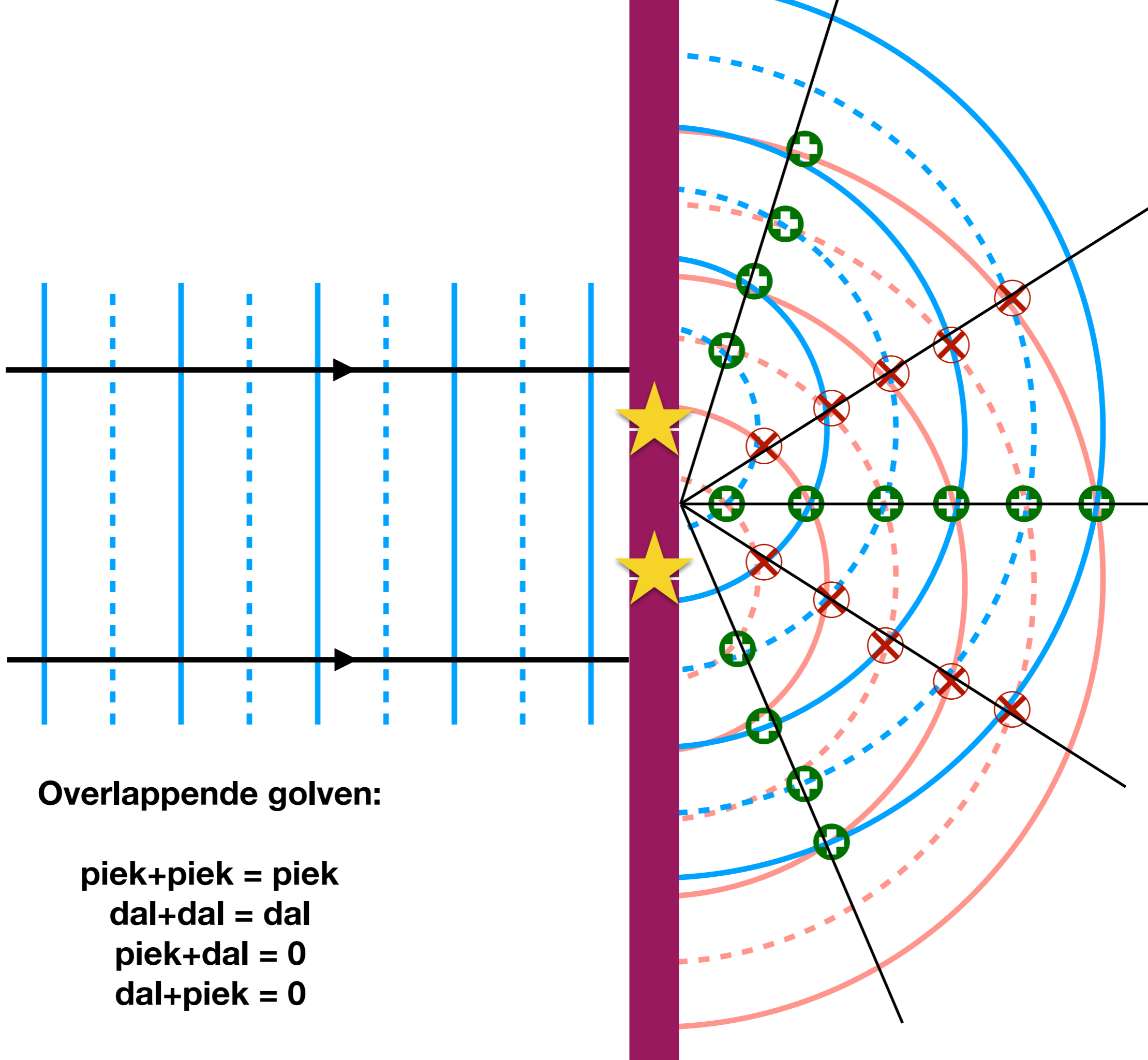
piek+dal = 0

dal+piek = 0



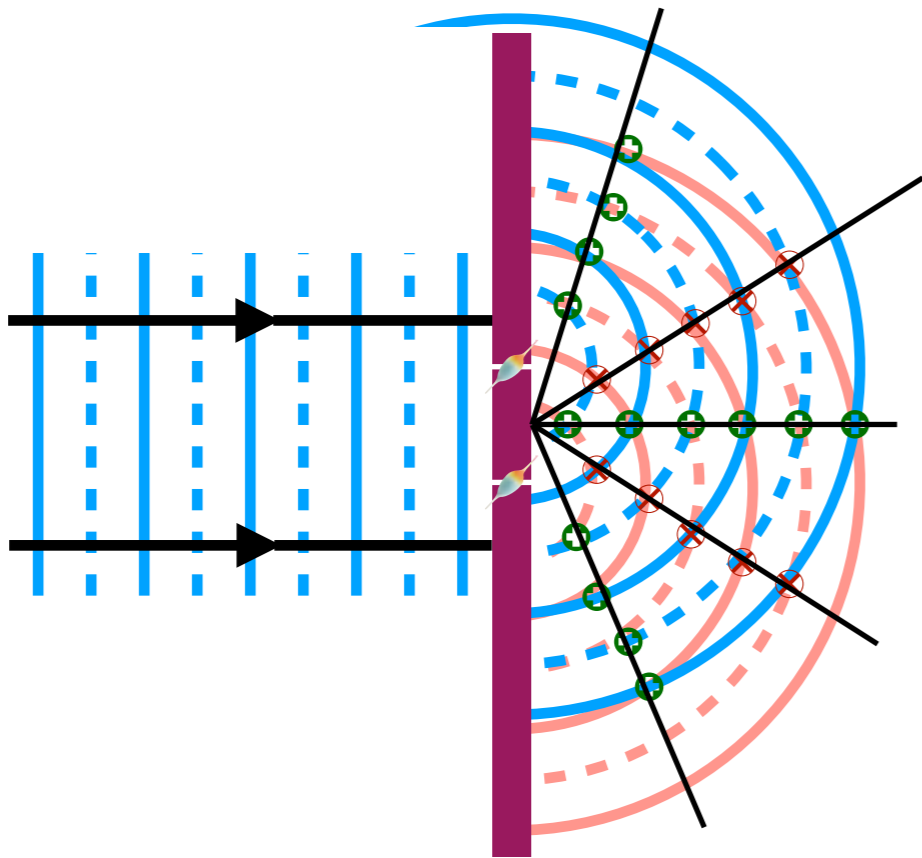
Overlappende golven:

- piek+piek = piek**
- dal+dal = dal**
- piek+dal = 0**
- dal+piek = 0**



Overlappende golven:

- piek+piek = piek**
- dal+dal = dal**
- piek+dal = 0**
- dal+piek = 0**

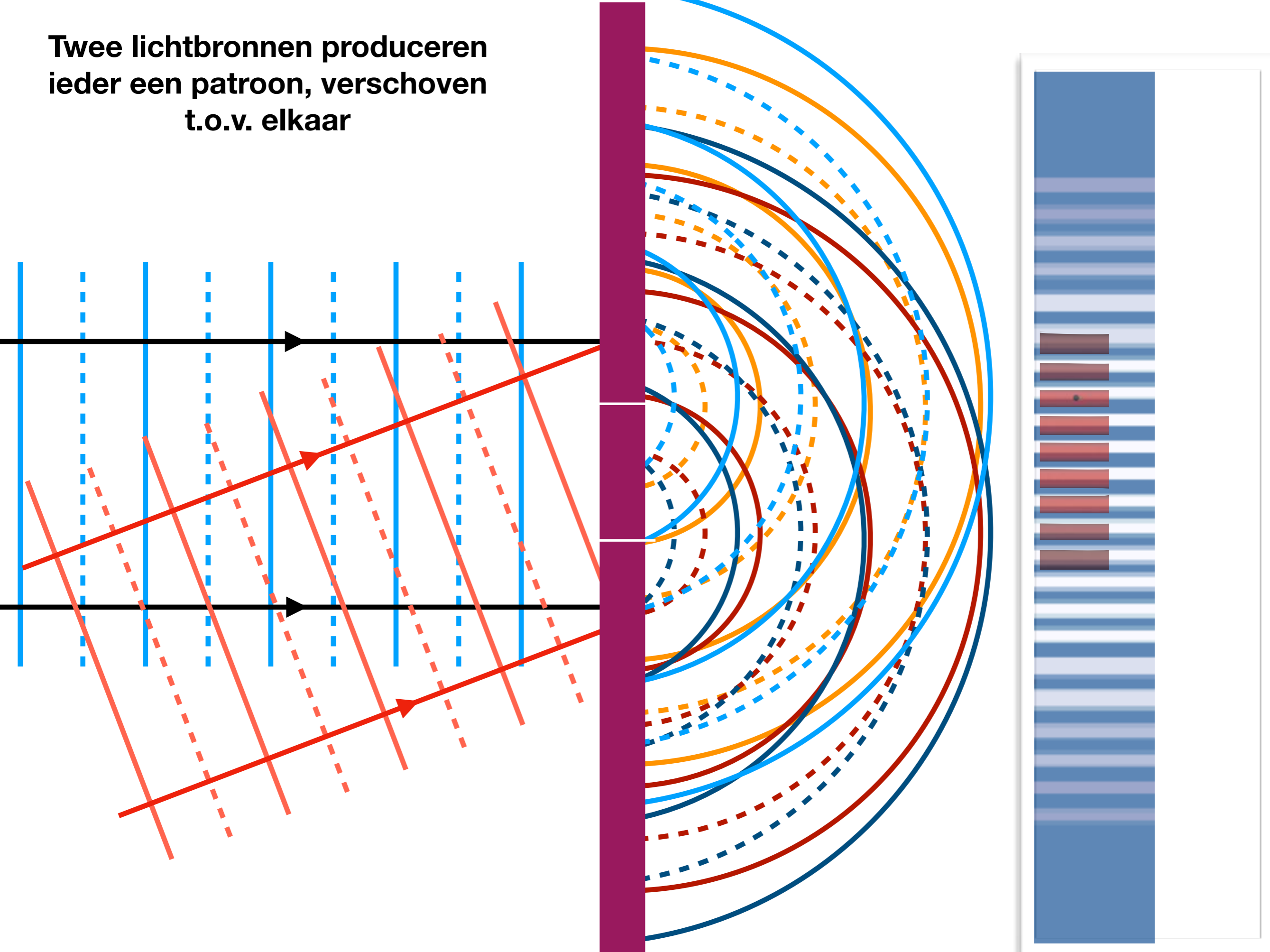


Interferentiepatroon

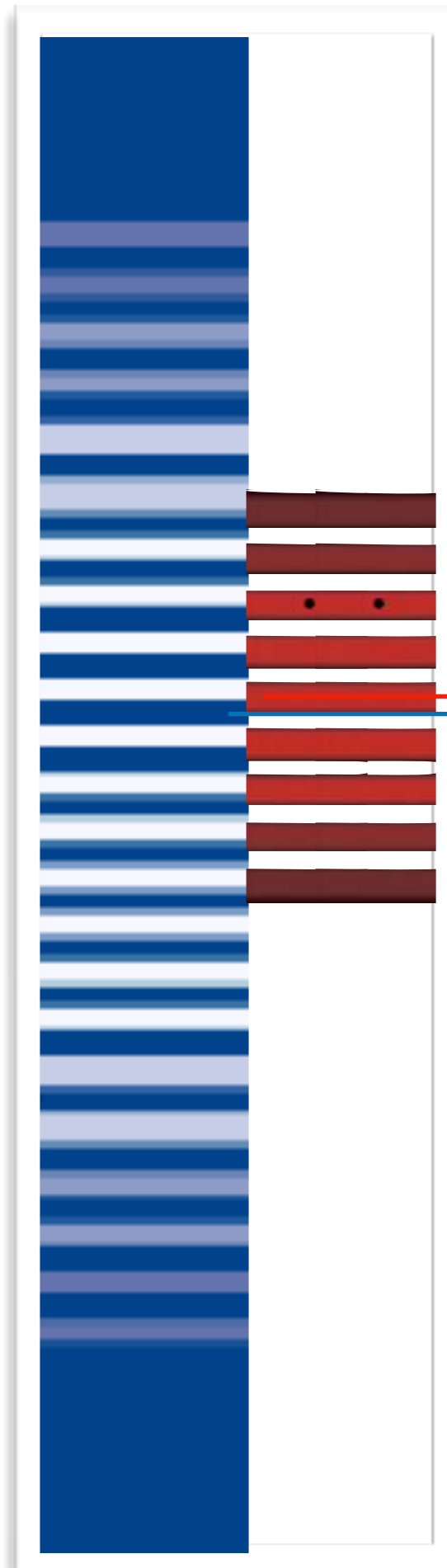
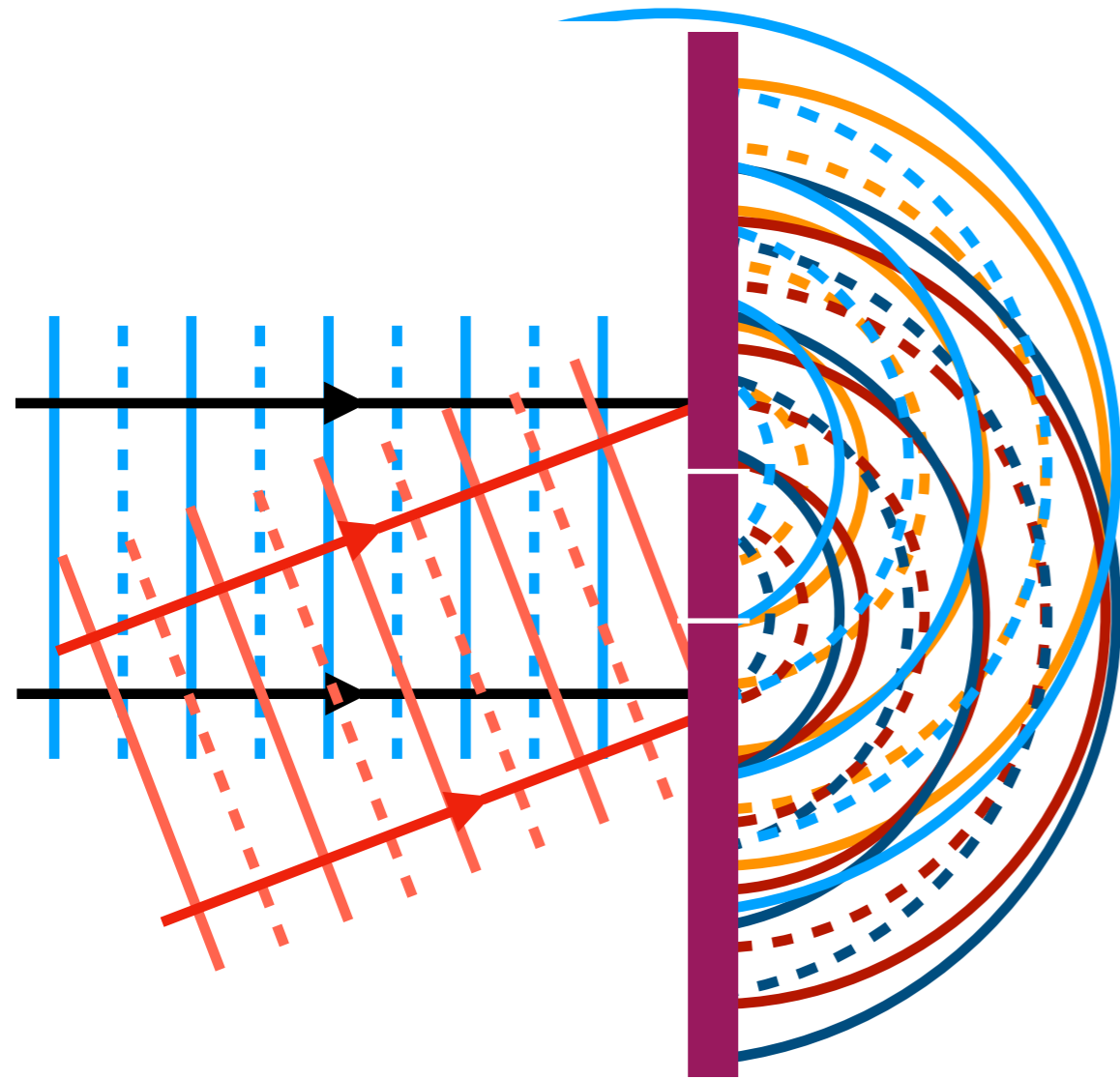
Afstand
tussen strepen
=
golflengte / b

b is de
afstand tussen
de gaatjes in
het scherm

**Twee lichtbronnen produceren
ieder een patroon, verschoven
t.o.v. elkaar**



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ieder een patroon, verschoven
t.o.v. elkaar**



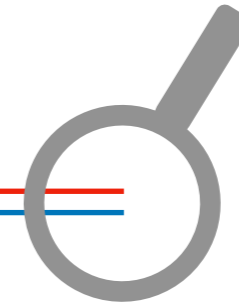
Verschuiving



**relatieve plaats van
de lichtbronnen**



**hieruit kan afbeelding
worden gereconstrueerd**



**Afstand tussen strepen
geeft limiet op
nauwkeurigheid:
beeldscherpte =
golflengte / afstand b**

Enkele telescoop:
scherpte \sim golflengte / diameter



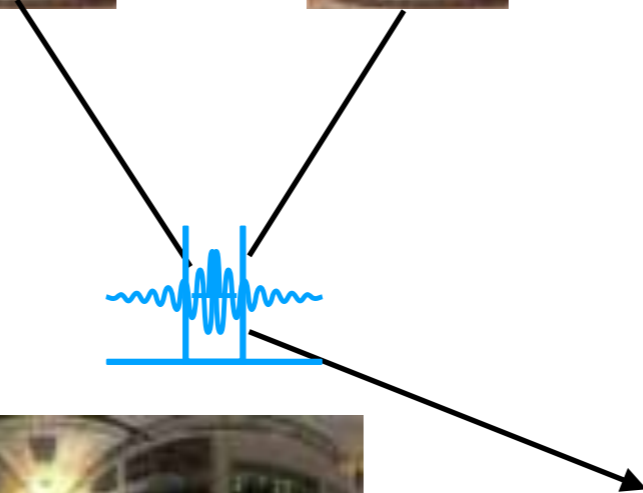
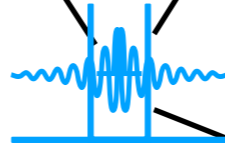
1-10 m

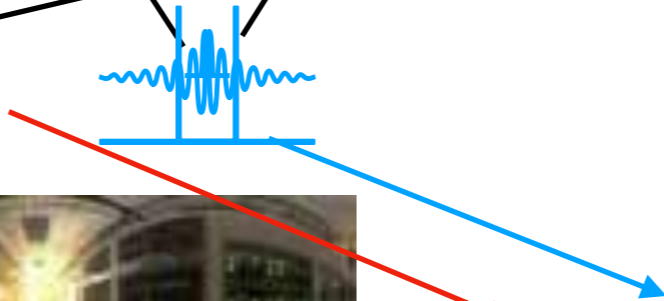
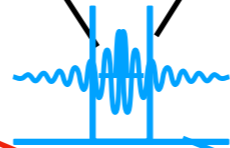
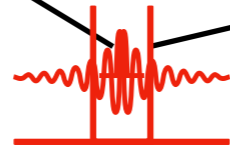
Interferometer:
scherpte \sim golflengte / maximale afstand tussen elementen

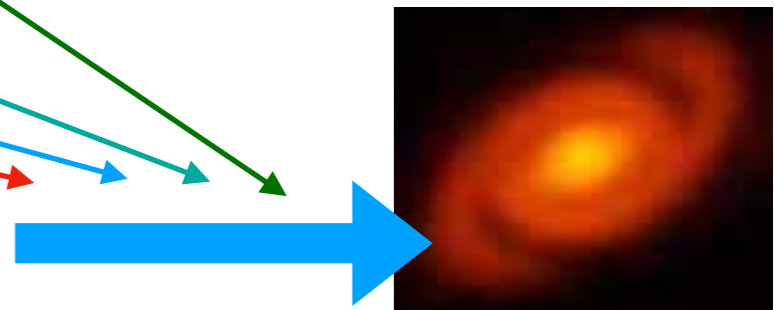
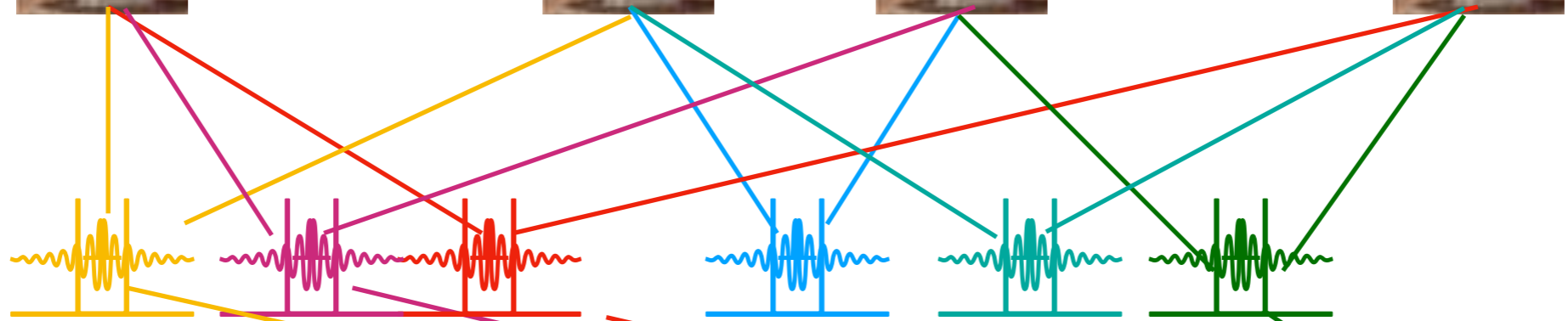
1-15 km





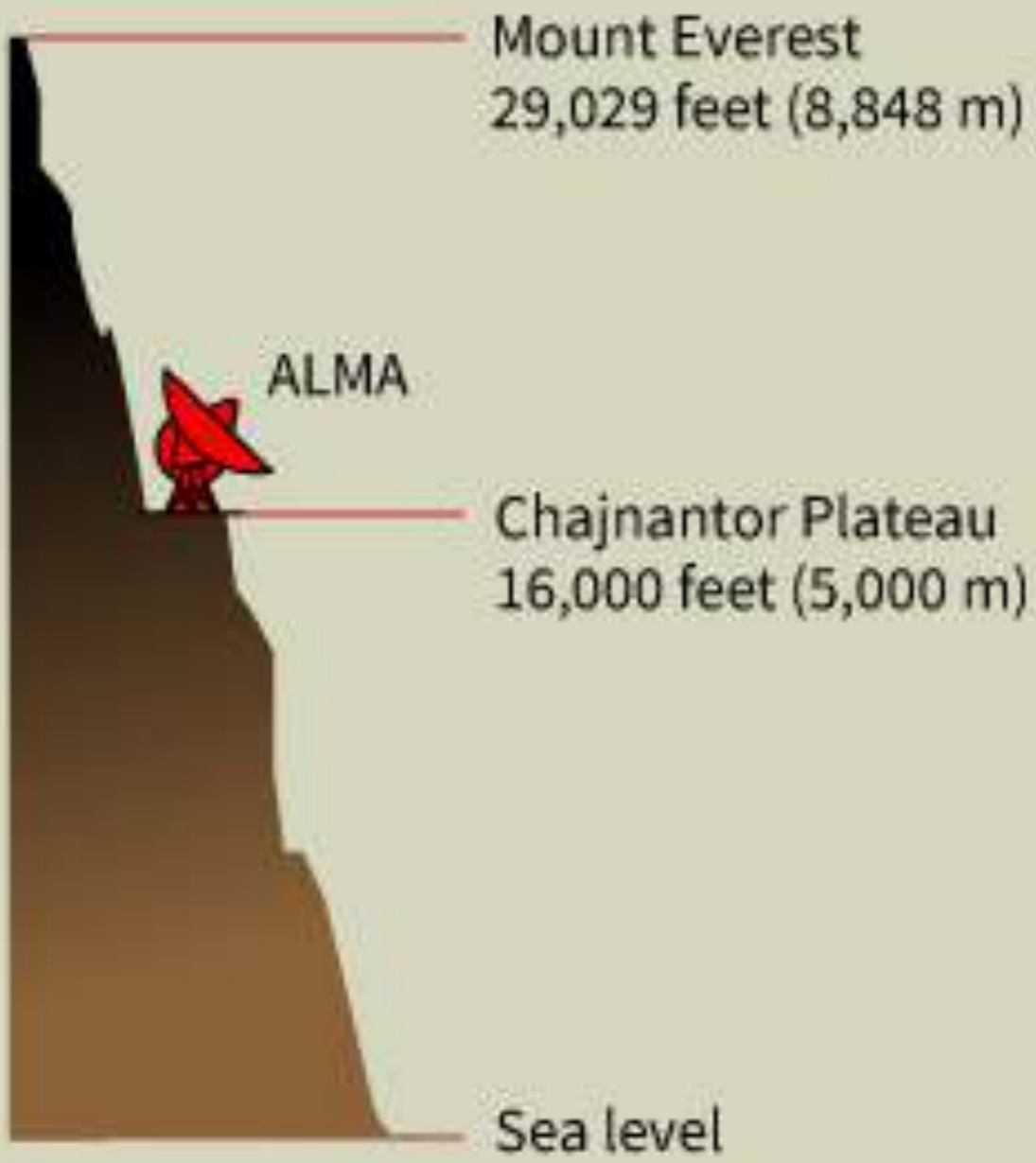


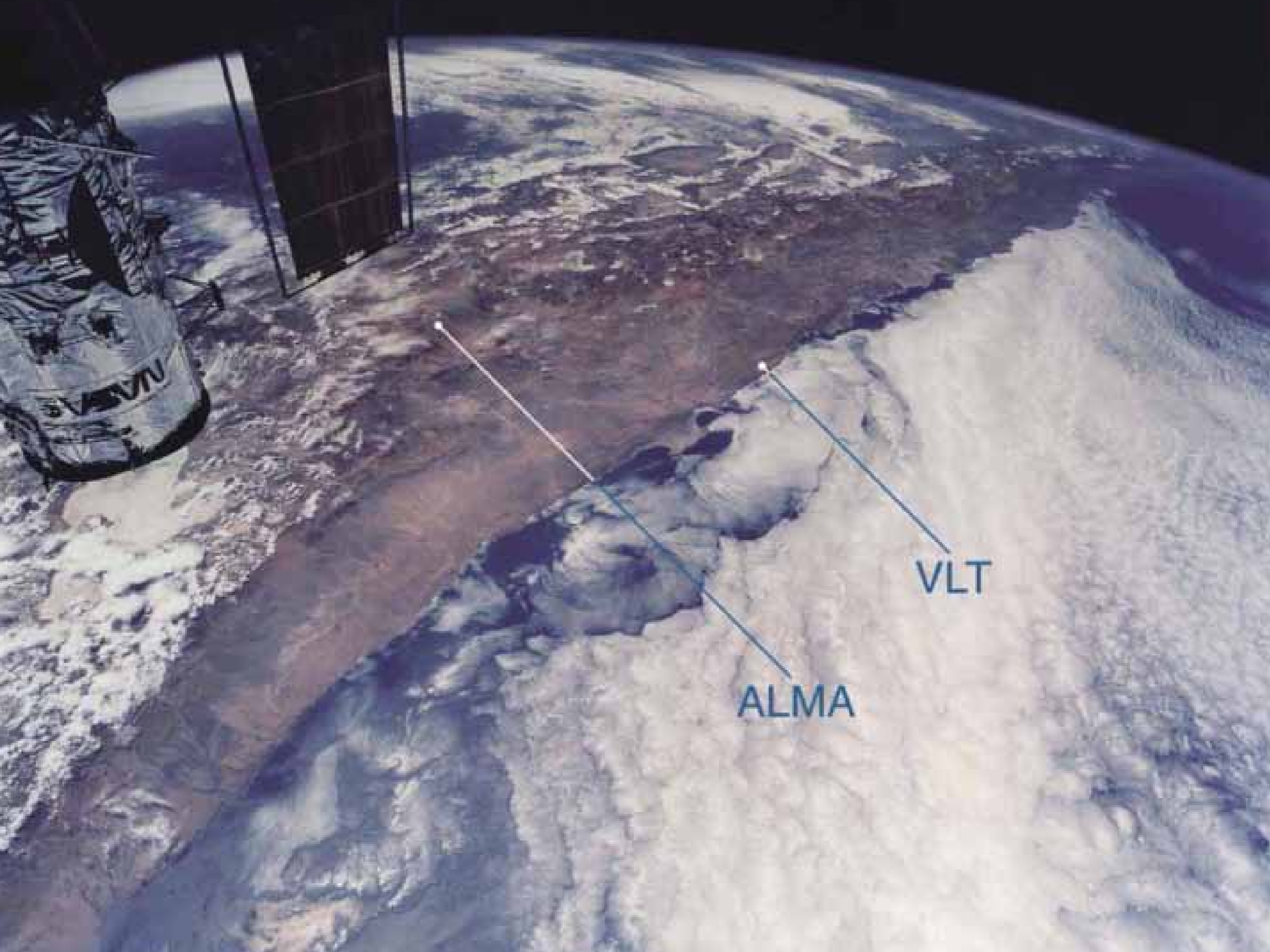




Chajnantor Plateau, Chile

The water vapor in the Earth's atmosphere absorbs radio waves, making radio astronomy difficult from sea level. The plateau's elevation (16,000 feet, or about 5,000 meters) places it above 40 percent of the Earth's atmosphere.





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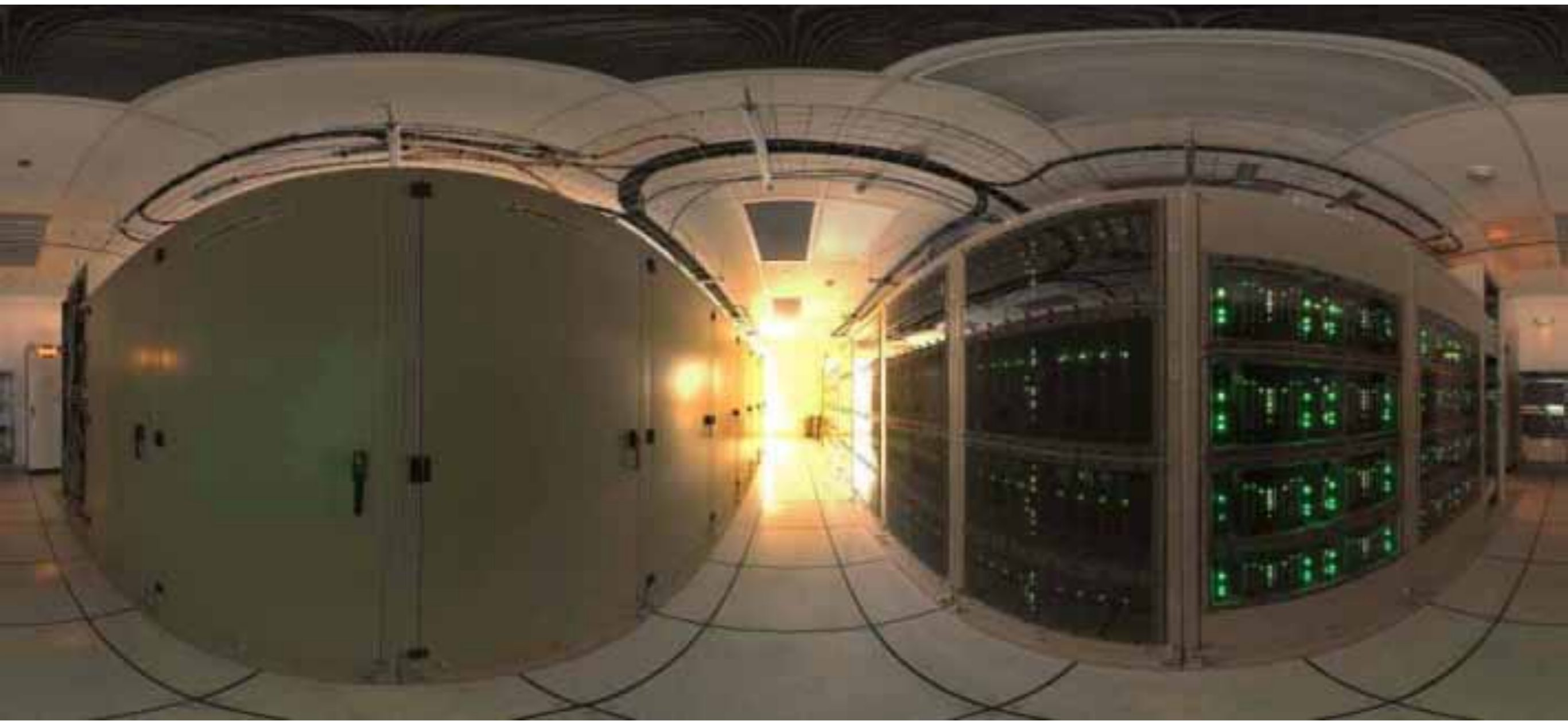


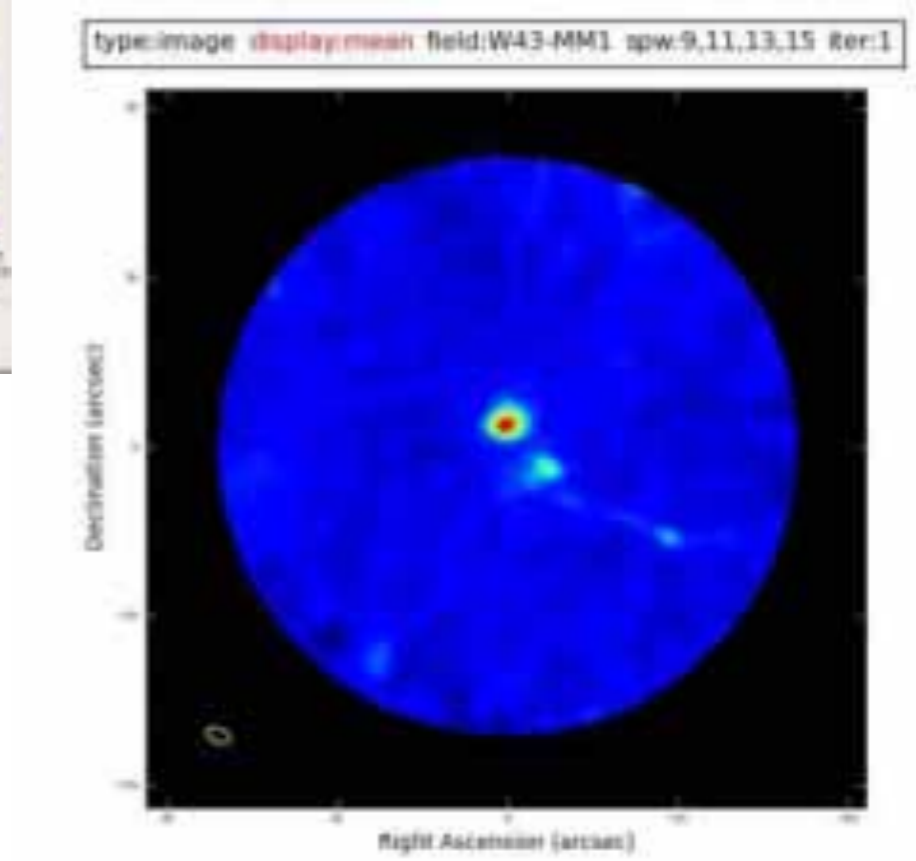
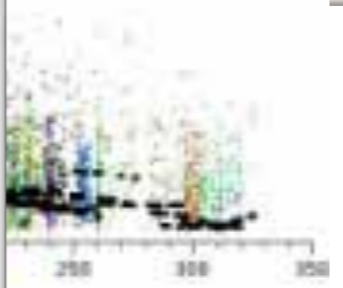
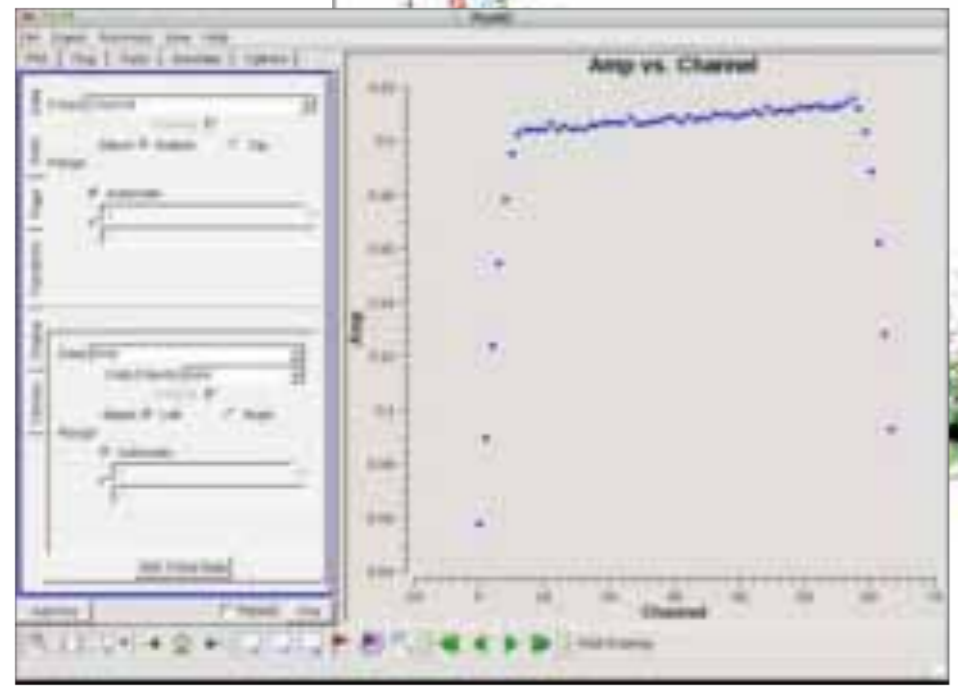
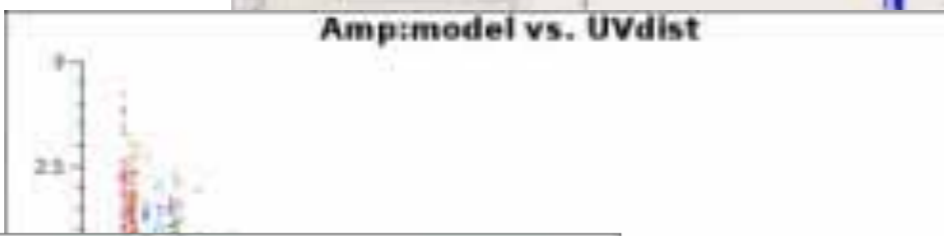
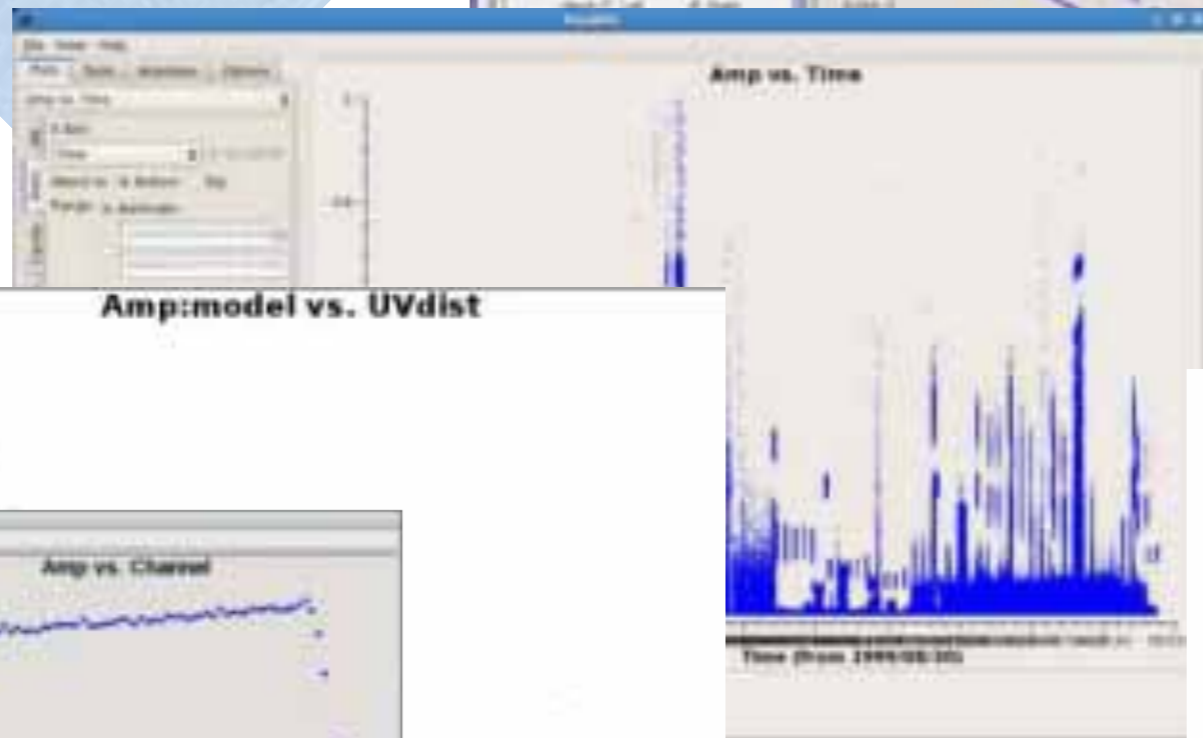
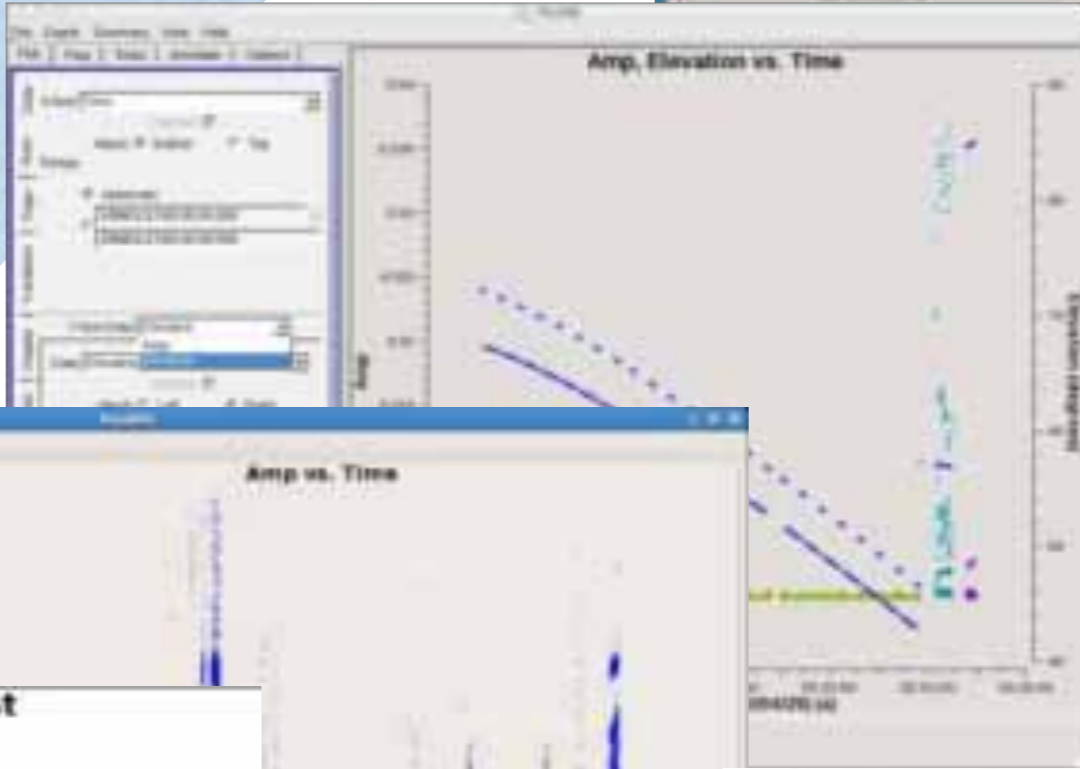
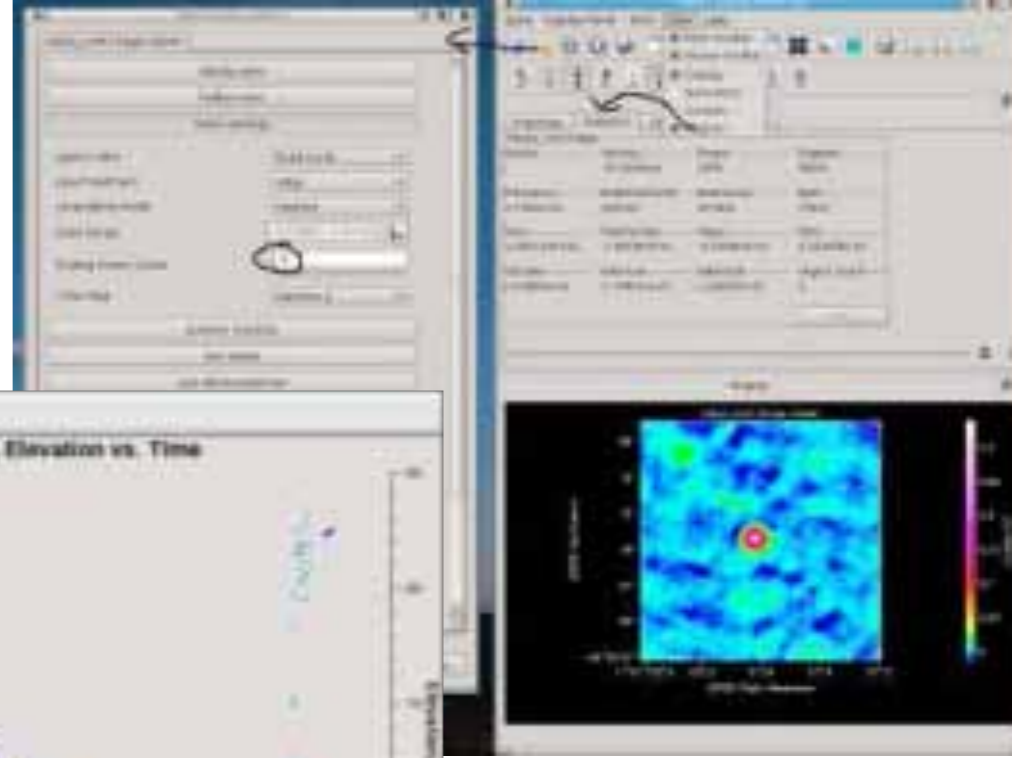
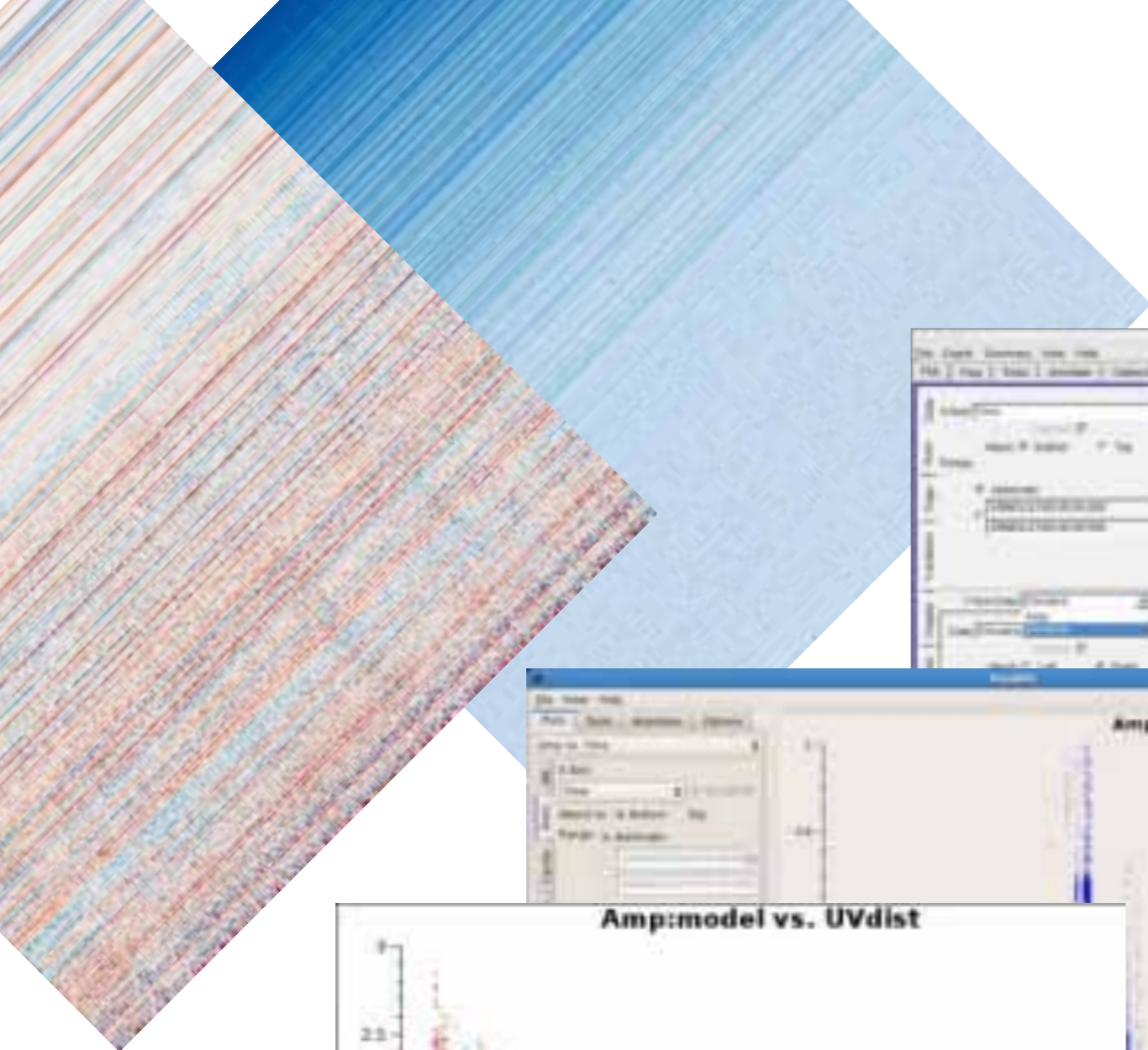


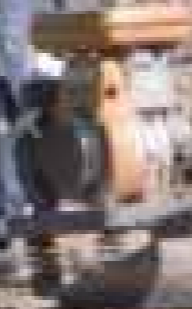
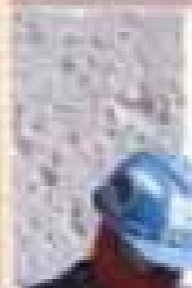












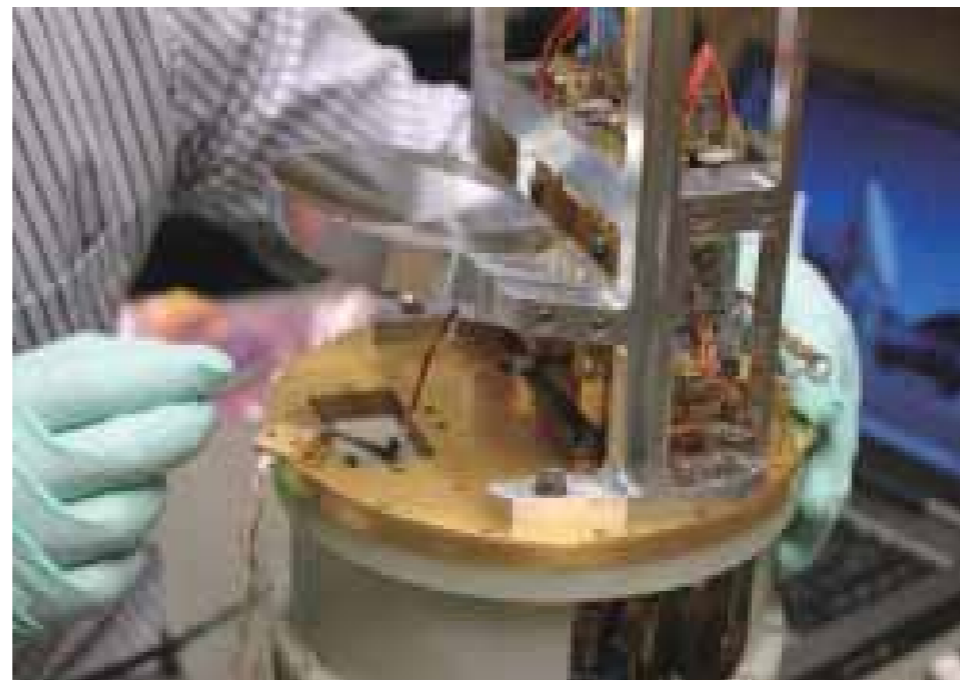












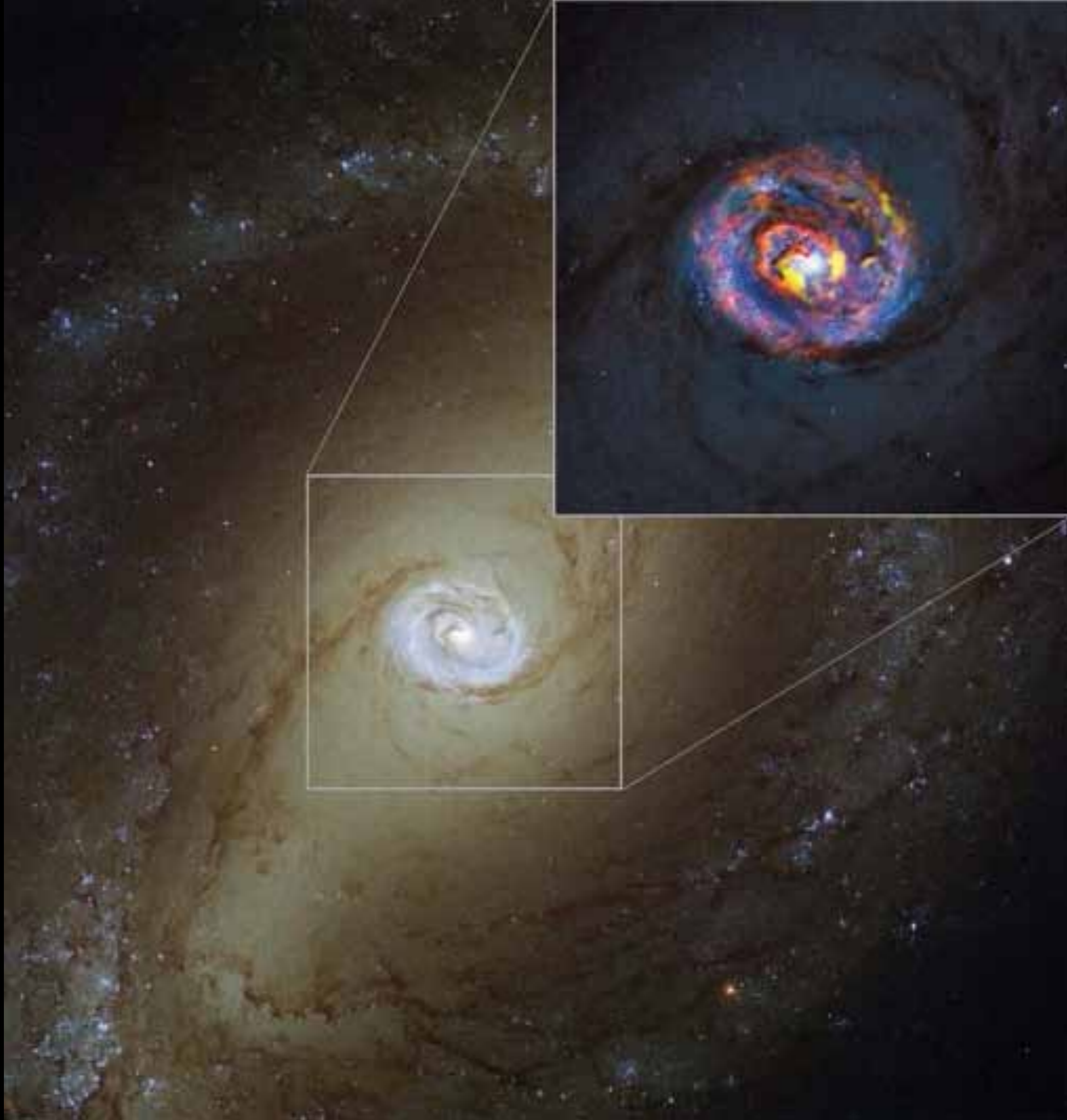


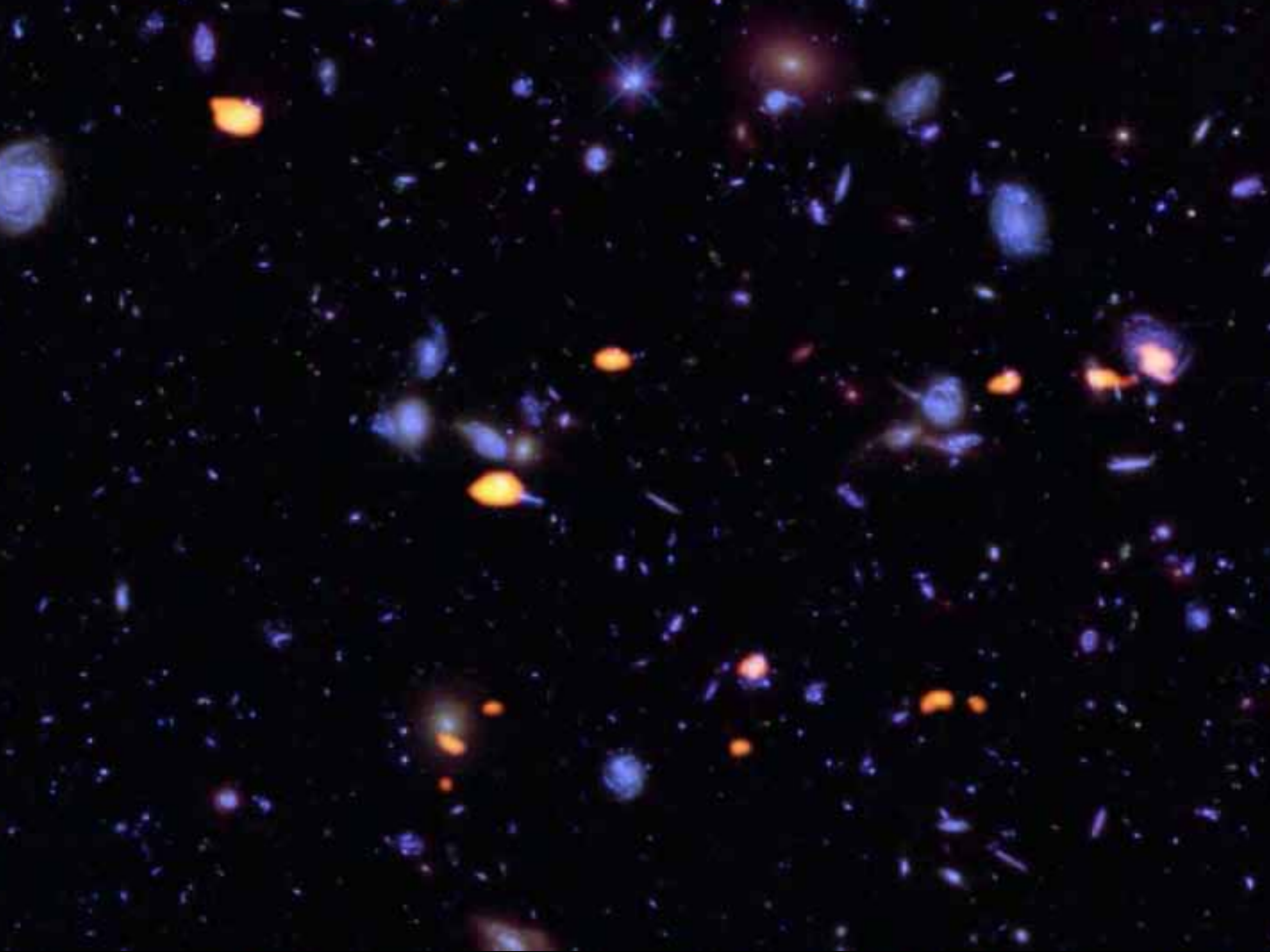


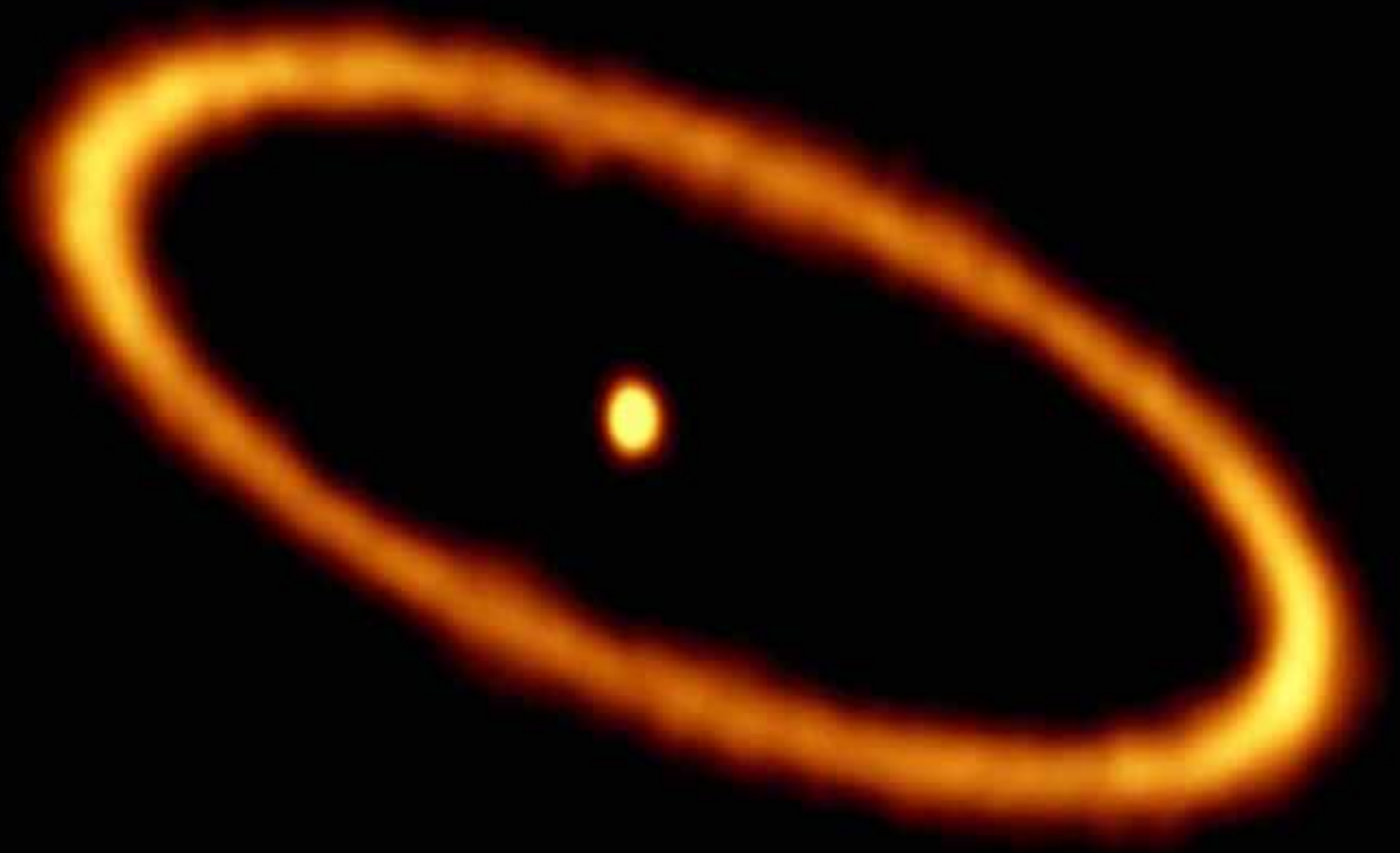










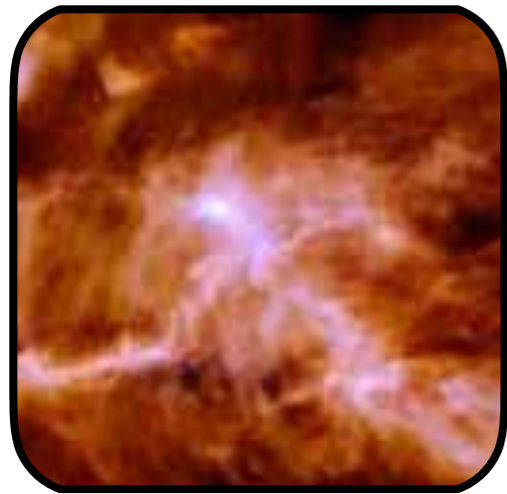








Planeetvorming in 10 stappen



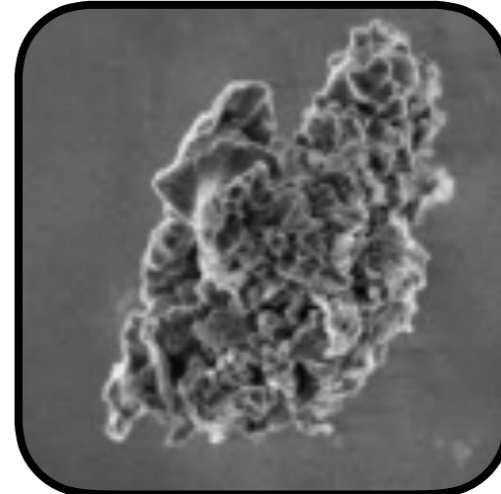
1. Wolk stort in



2. Ster gaat stralen



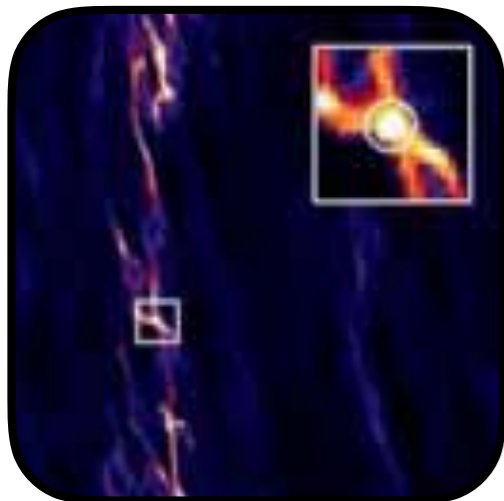
3. Schijf vormt



4. Stof klontert samen



5. Ijslaagjes kleven



6. Verzameling van kiezels trekken samen



7. Oligarchische groei



8. Grote rotskernen vangen gas in



9. Planeten migreren



10. Inslagen bezorgen atmosfeer en oceaan