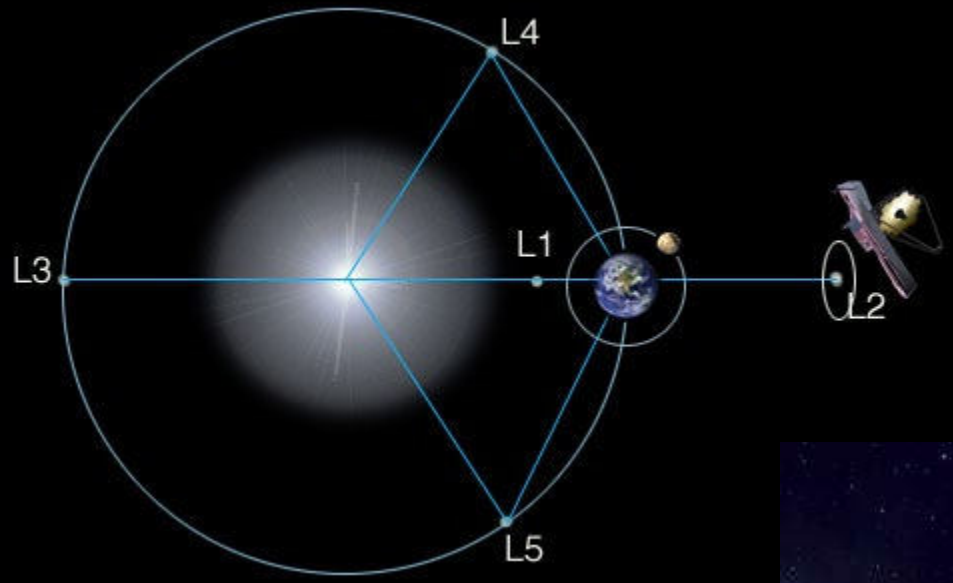
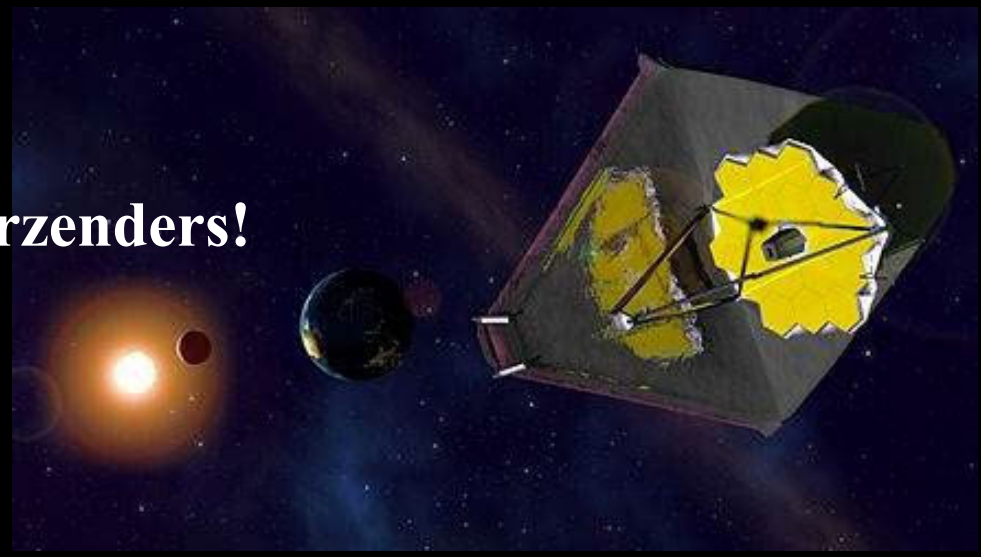
Webb baan en zonneschild

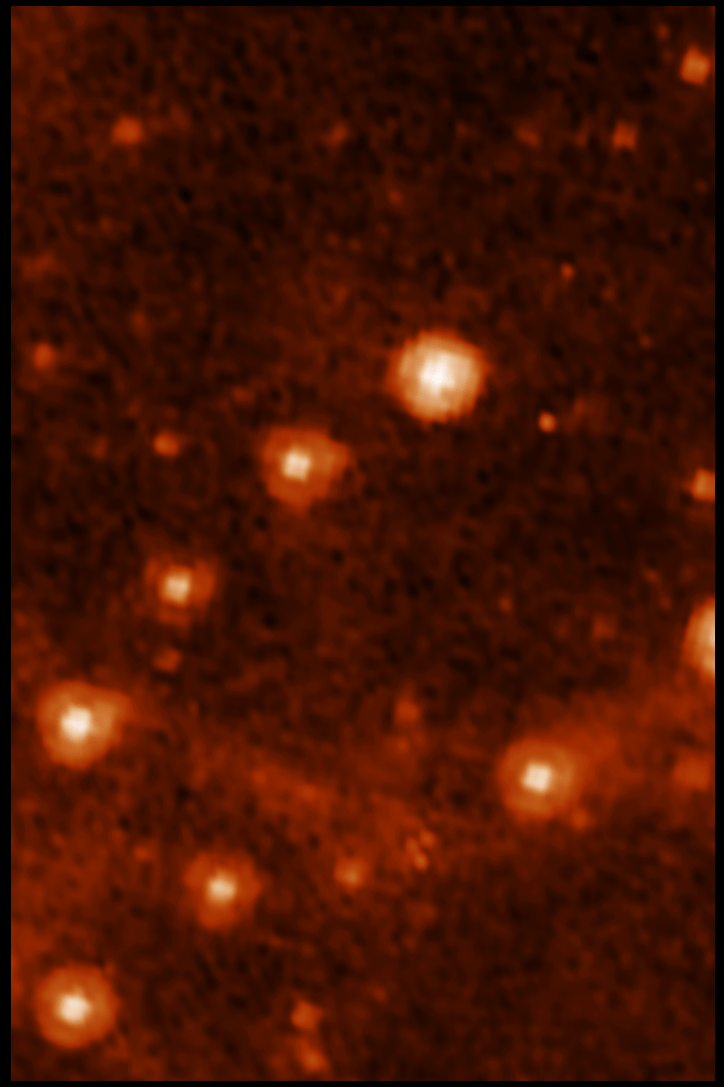


Zon, aarde en maan zijn stoorzenders!



Zon, aarde en maan aan zelfde kant

MIRI is koud en ziet scherp!



Spitzer vs MIRI
Large Magellanic Cloud

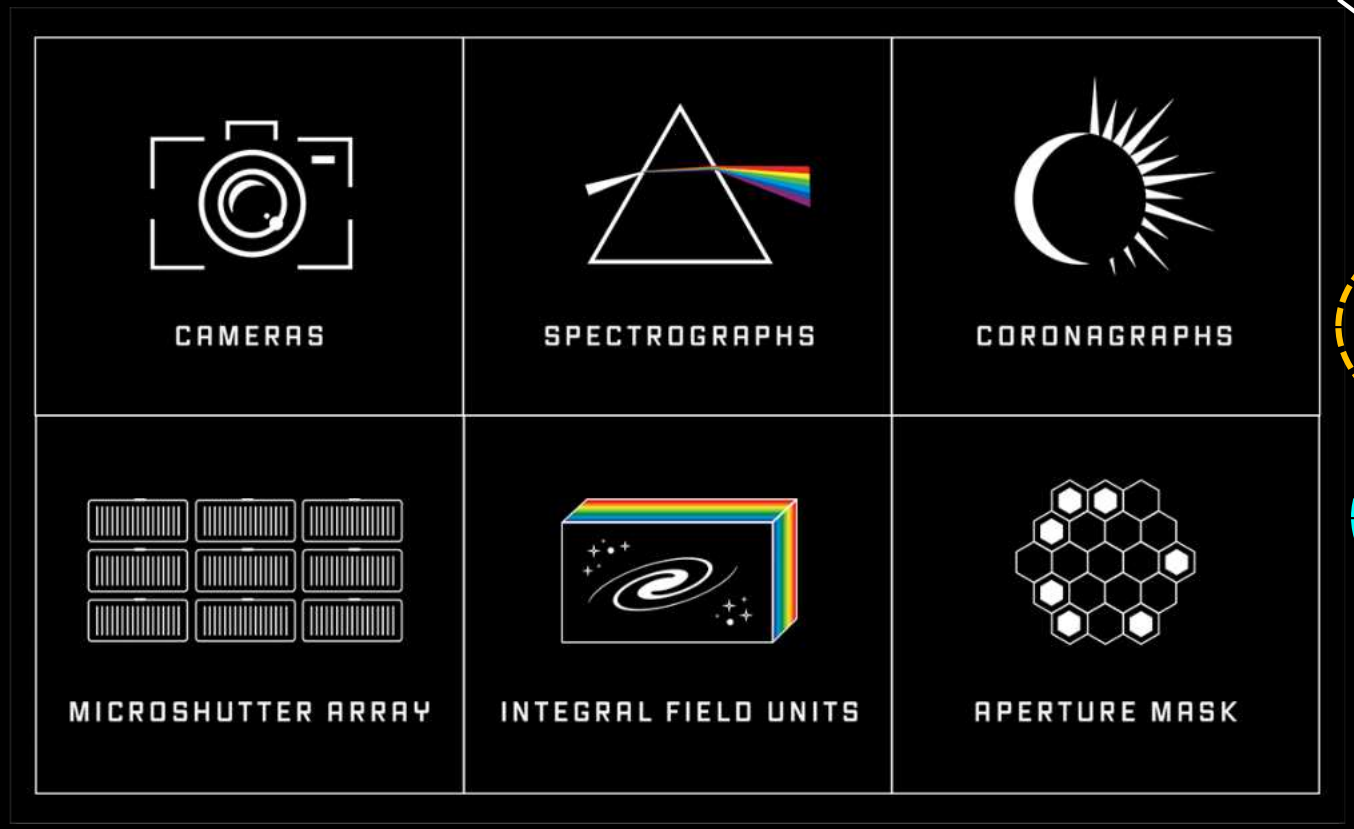
April 2022

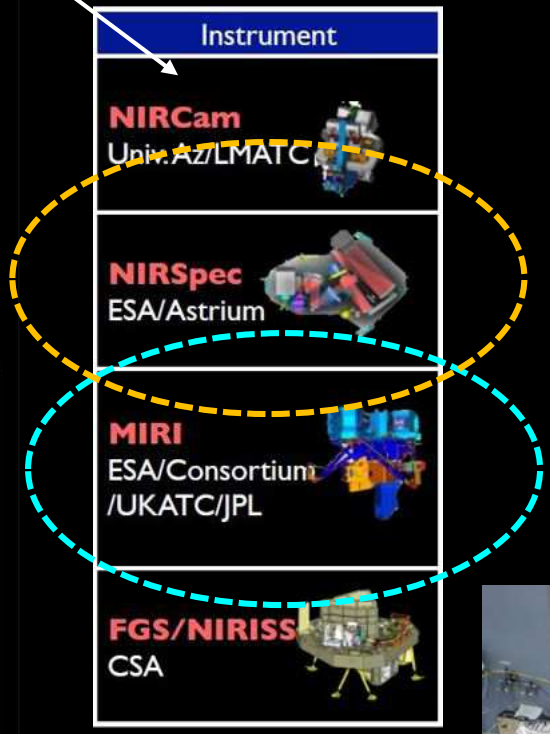
Waarom infrarood?
Kijken in donkere stoffige wolken

Geboorte van sterren en planeten

Vier instrumenten op Webb

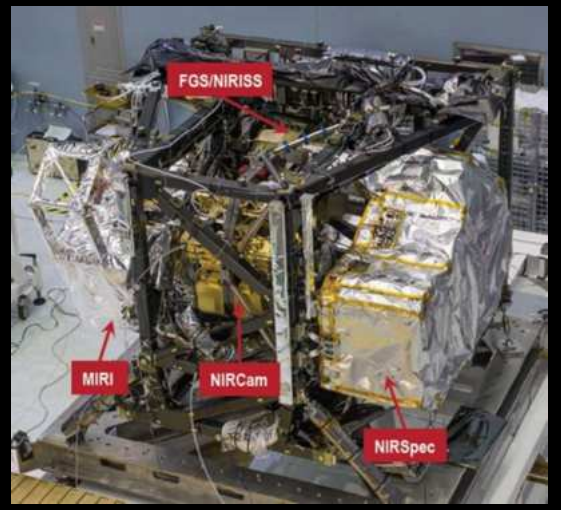
Dit maakt de mooie plaatjes





1-5 μm
(2000-10000 cm^{-1})

5-28 μm
(300-2000 cm^{-1})



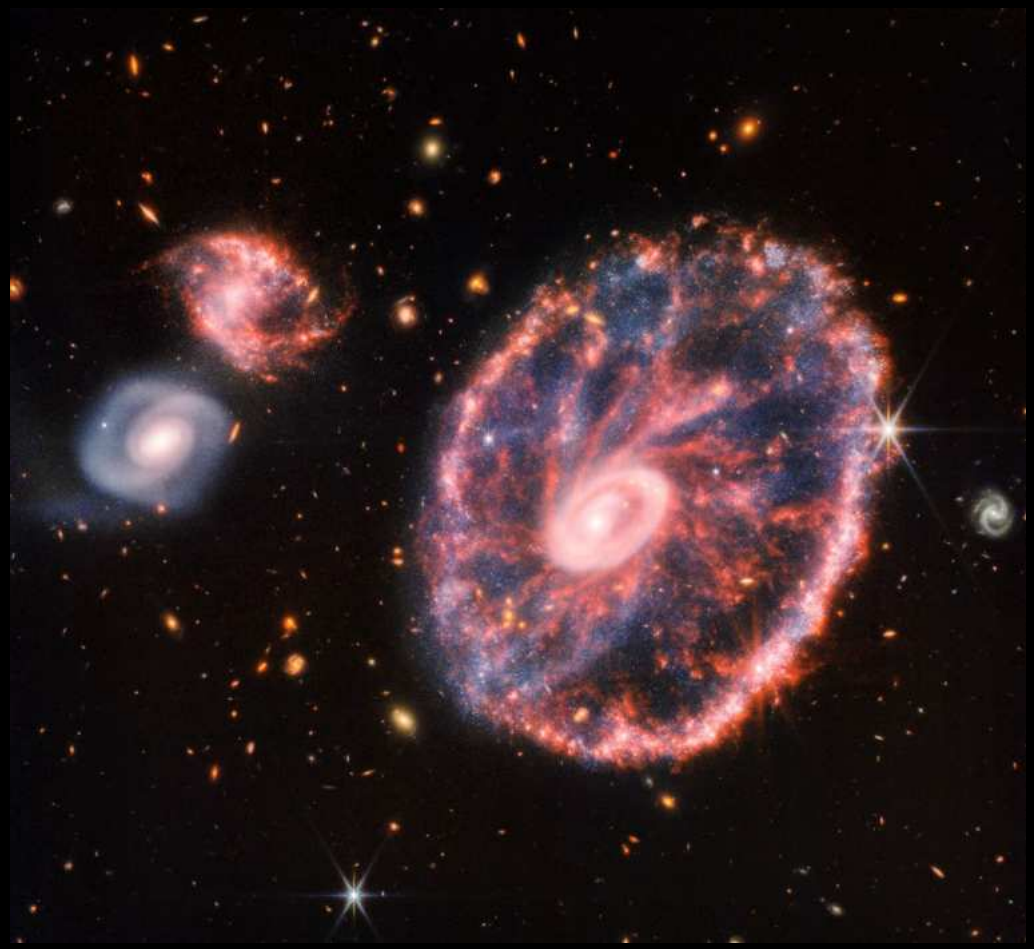
Gevoeligheid factor 100-1000 beter dan eerdere instrumenten
Spectrale resolutie $R=\lambda/\delta\lambda$~3000
→ *Ontdekkings ruimte!*

Prachtige sterrenstelsels met Webb

M74
Phantom
Galaxy

NASA/ESA/CSA/STScI

Prachtige sterrenstelsels met Webb



Cartwheel galaxy

NASA/ESA/CSA/STScI

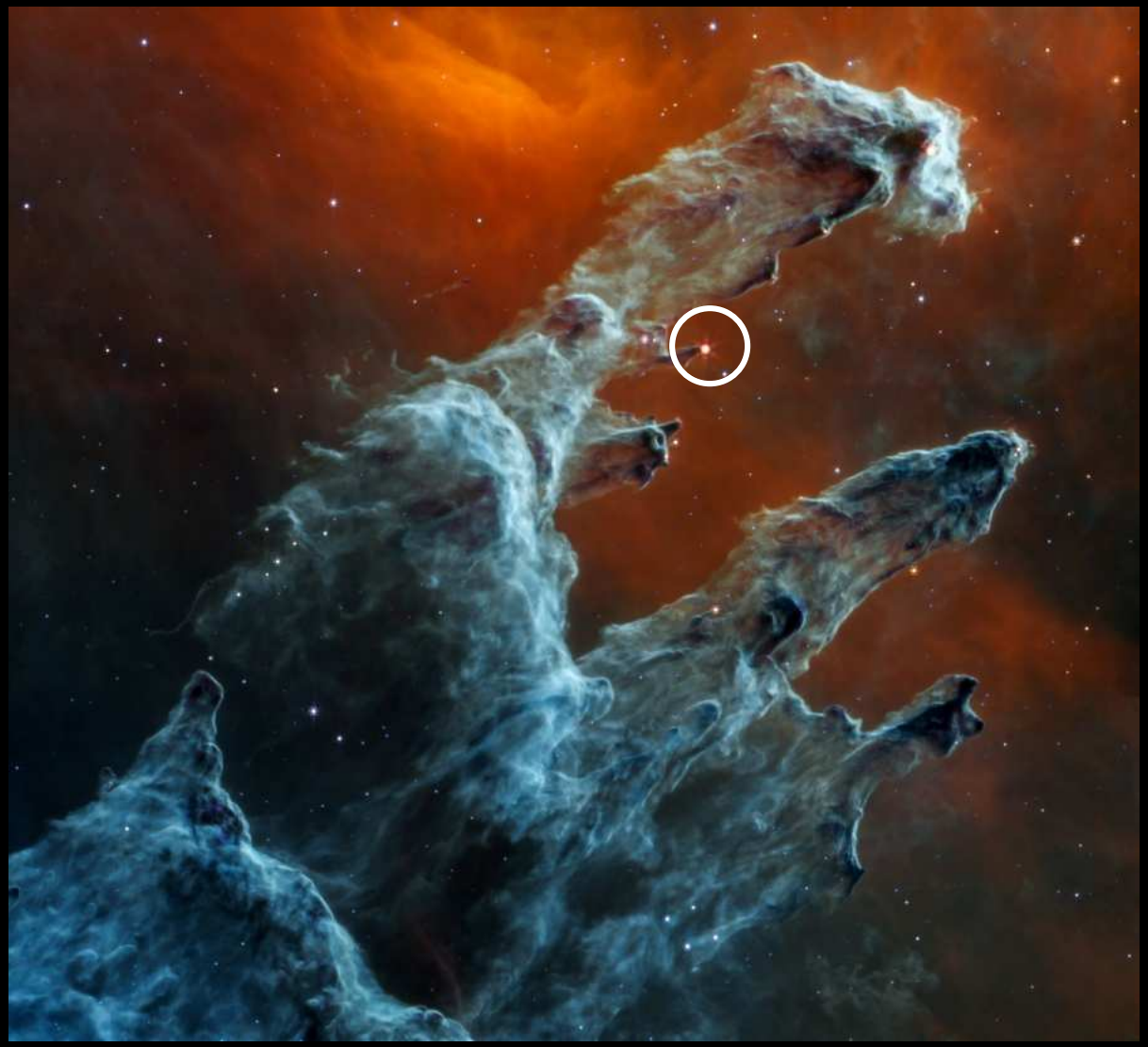
En meer!

NASA/ESA/CSA/STScI/Phangs

Carina nevel met Webb

2 lichtjaar

Star formation: “Pillars of Creation”

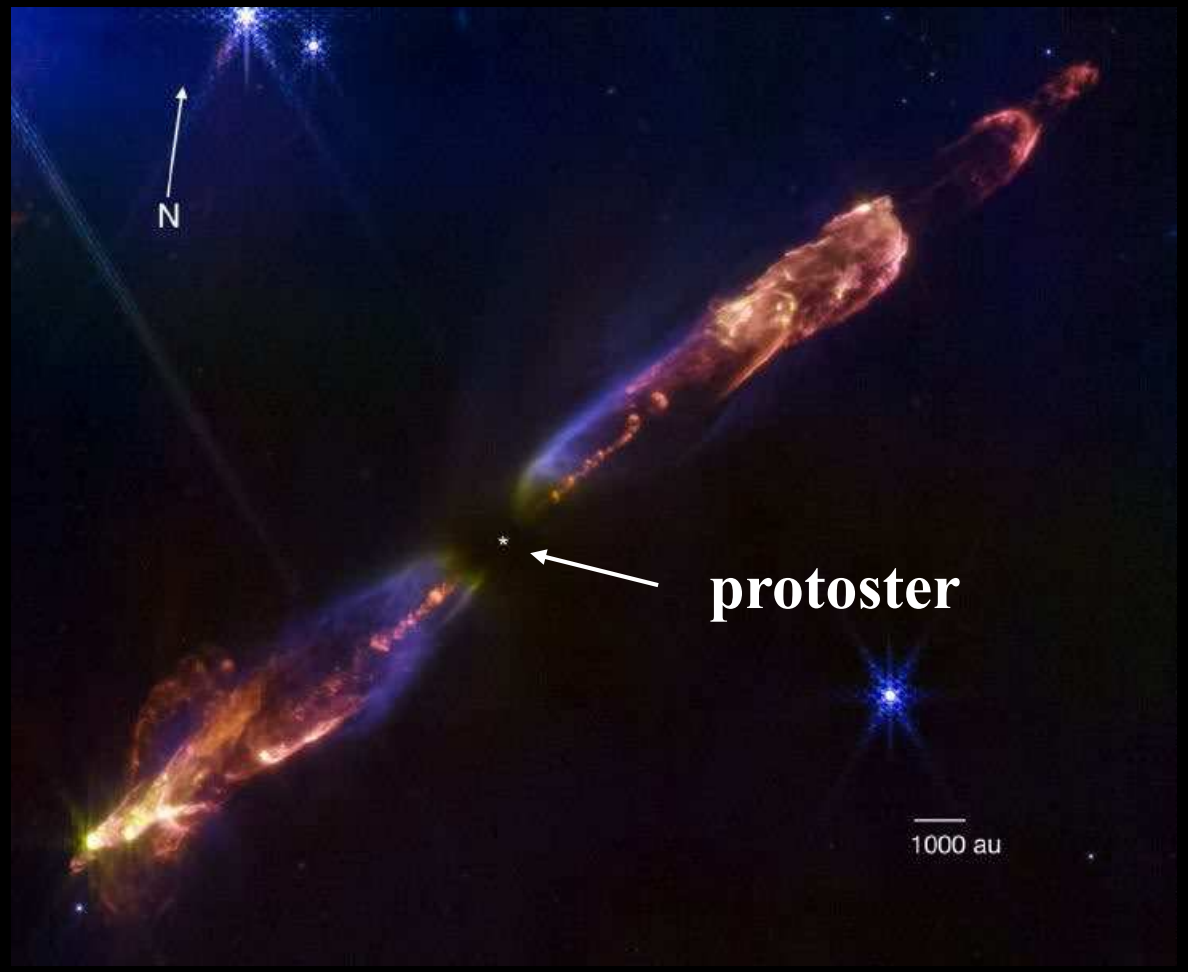


JWST-MIRI

Stervorming in donkere wolken

Webb
Ophiuchus
July 12 2023

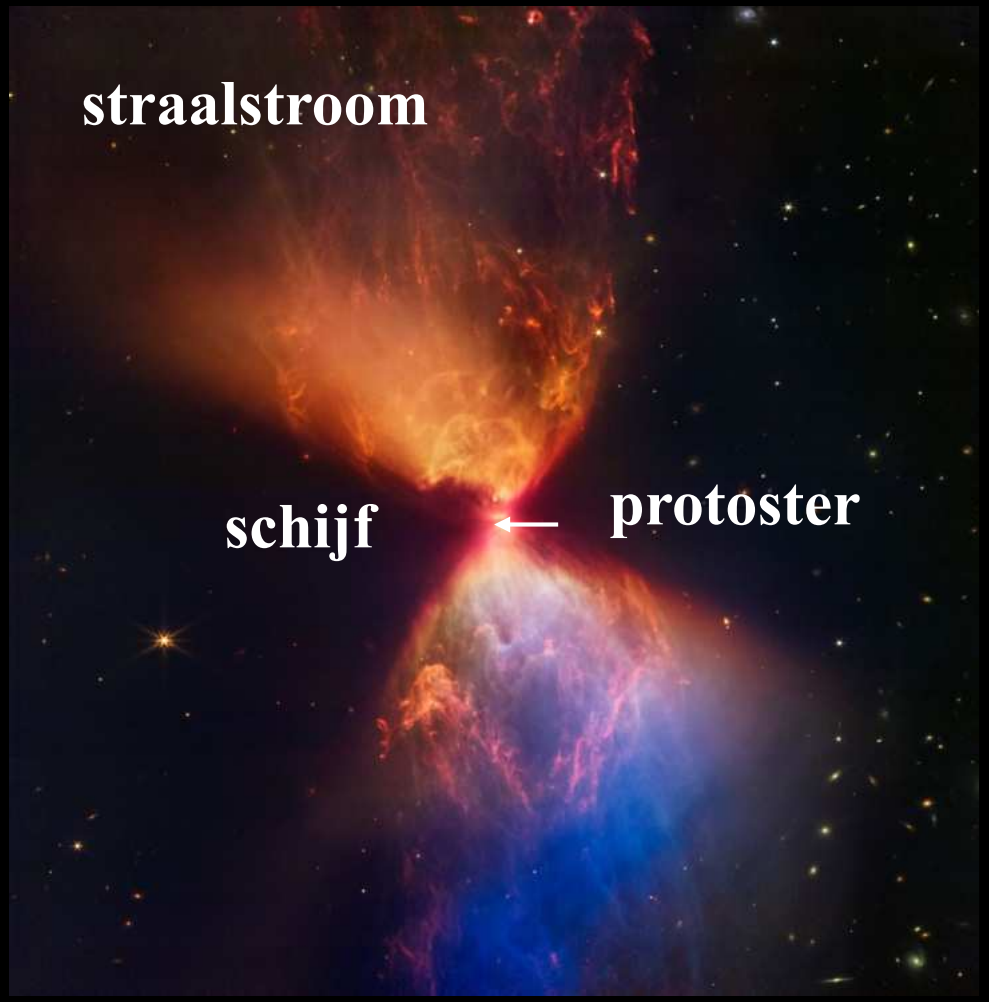
Protoster met jet



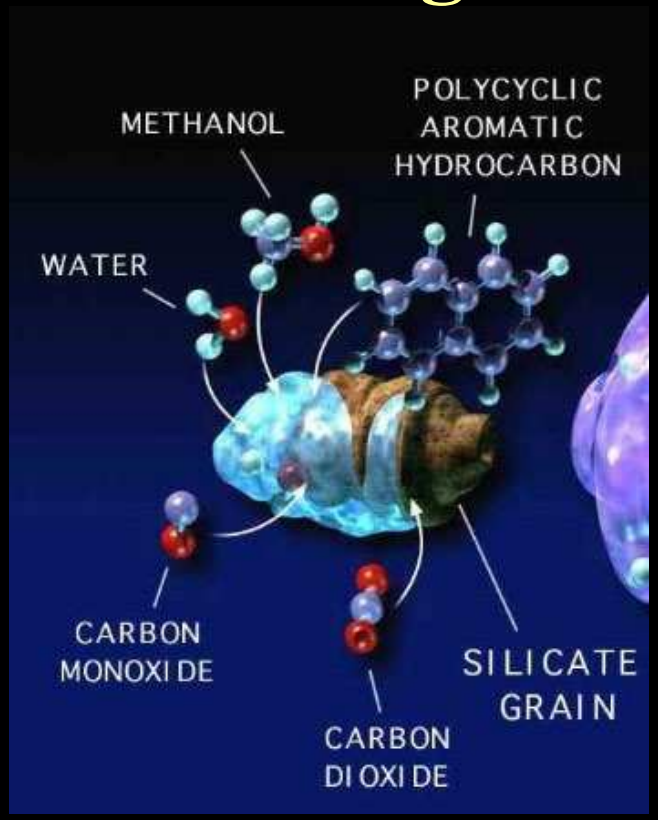
Onze “baby”zon toen het 10000 jaar oud was

JWST-NIRCAM
T. Ray et al. 2023
NASA/ESA PR Sept. 14, 2023

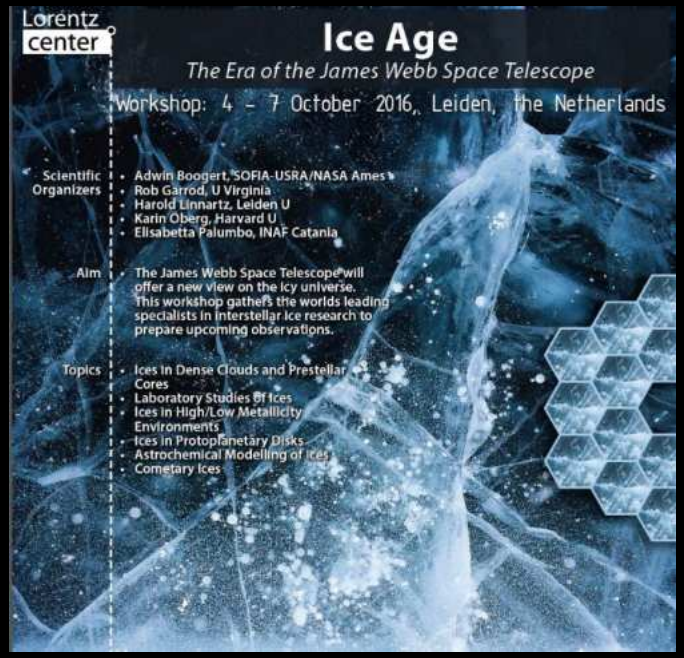
Protoster



“Ice Age”: GTO en ERS programs



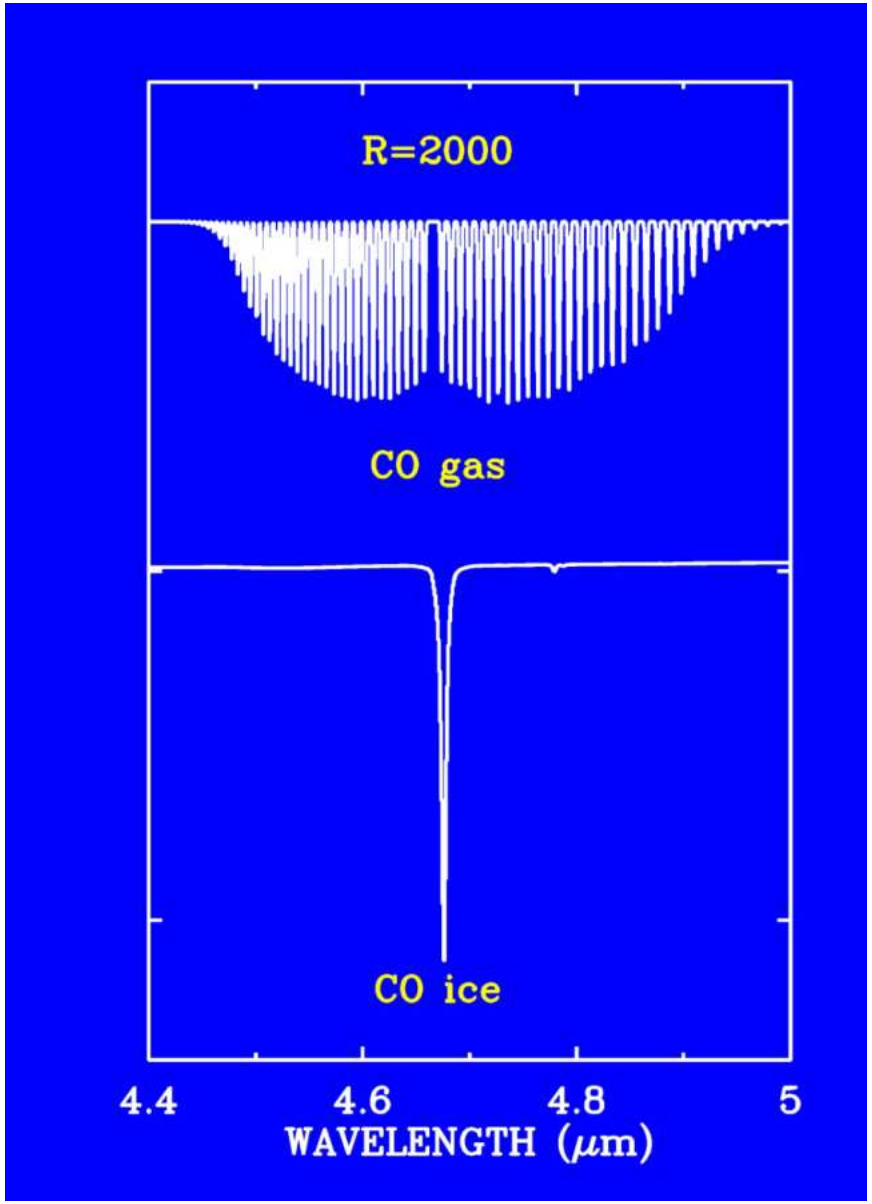
©Scientific American



Melissa McClure

Webb kan simple en complexe moleculen in ijzen meten en onderzoeken

Gas versus ijs: infrarood

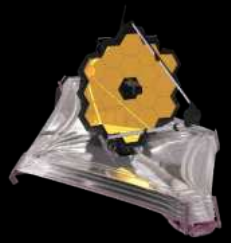


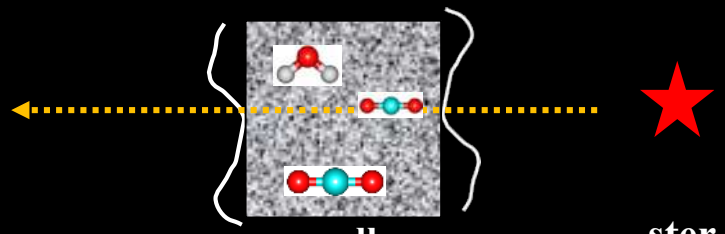
Interstellaire ijzen met Webb

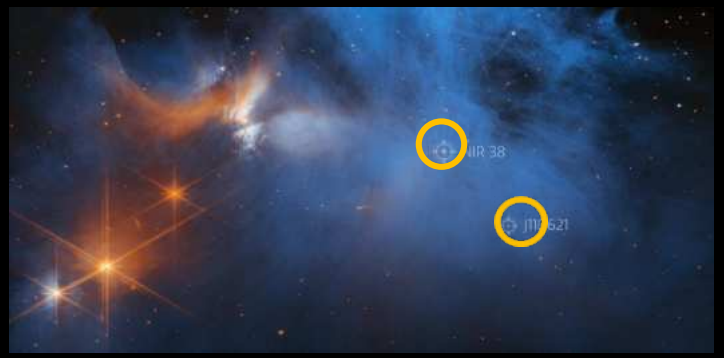
IceAge program

M. McClure

Chamelaeon wolk NIRCAM



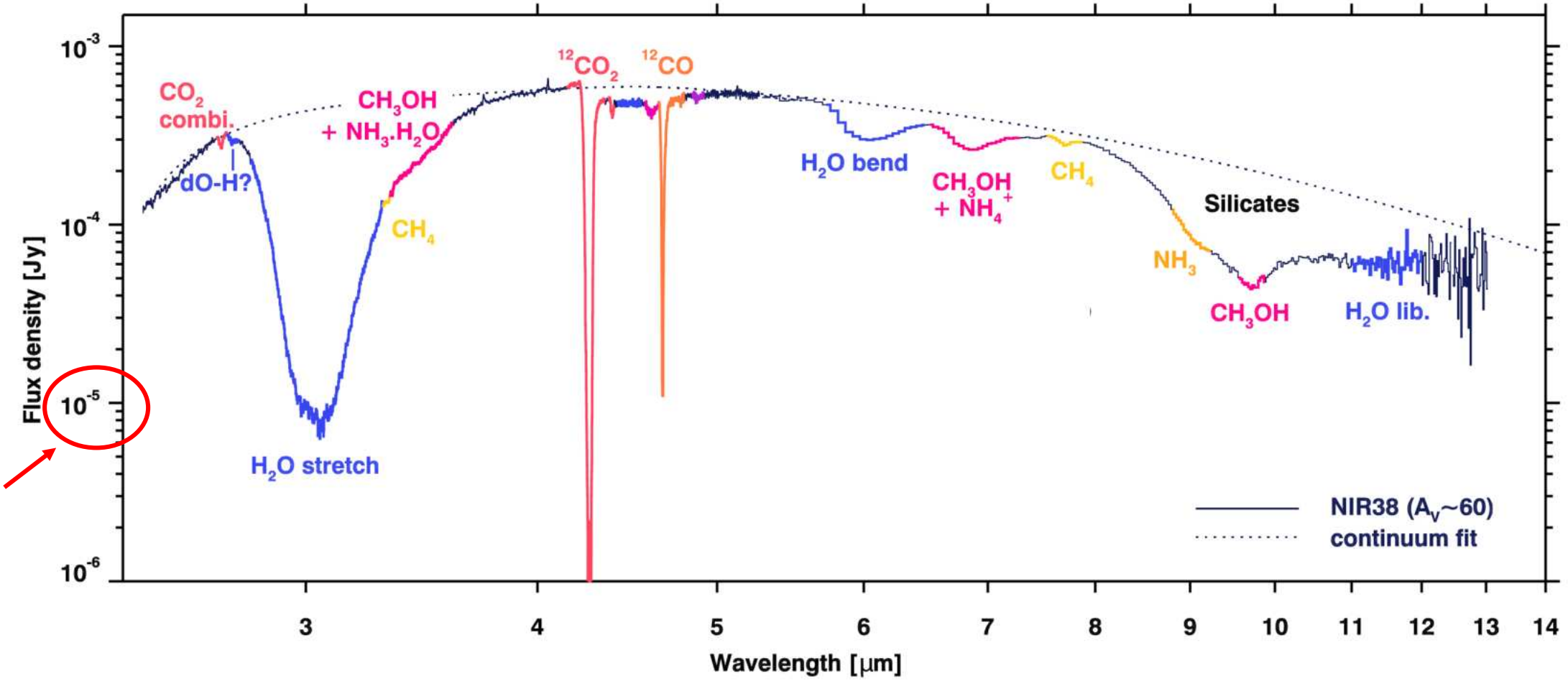




Twee achtergrondsterren met A_V=60 en 95 mag

De “donkerste” ijzen tot op heden!

NIRSPEC + MIRI-LRS

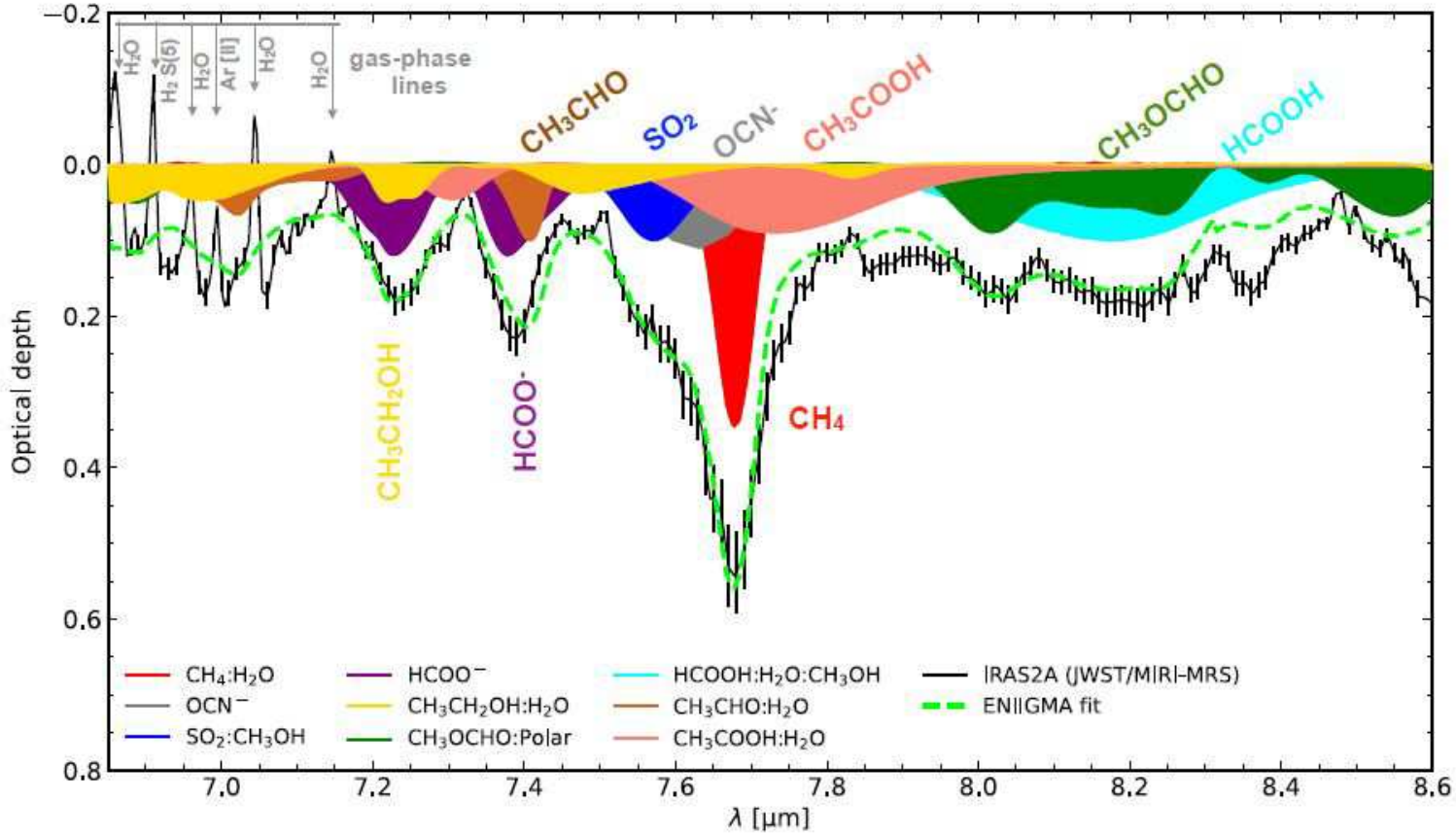


Merk op: 10 micro-Jy!

Inventarisatie ijzen voordat stervorming begint

McClure et al. 2023
(Nature Astronomy)

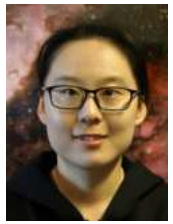
Protosterren: Methanol en complexe moleculen in ijzen



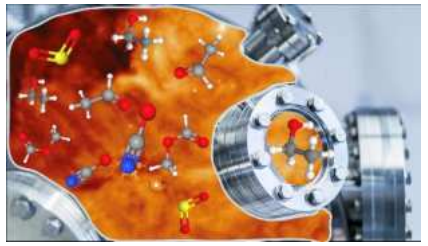
NGC1333 IRAS2A

Ook ionen (zout): OCN^-, $HCOO^-$

Rocha et al. 2024

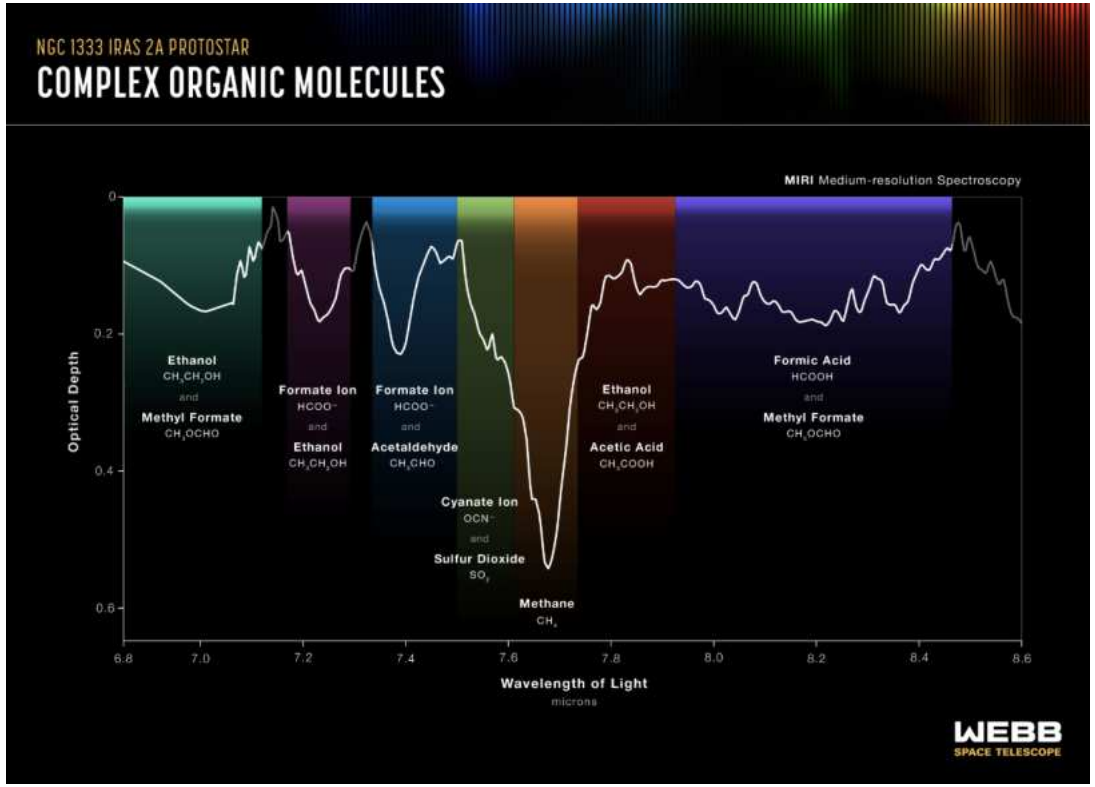


Yuan Chen et al. 2023, 2024 subm: gas vs ijs



NASA/ESA Press Release op 13 maart, 2024: Cheers!

Margaritas in de ruimte?



Rocha et al. (2024b)

CNN World Africa Americas Asia Australia China Europe India Middle East United Kingdom

The burning acid behind ant stings was spotted around two stars

By Ashley Strickland, CNN
4 minute read · Updated 5:55 PM EDT, Fri March 15, 2024

YAHOO! NEWS

Astronomers discover the ingredients for habitable worlds — and maybe a cocktail — around two baby stars

Yahoo! News, 15 Mar 2024

SPACE.com

James Webb Space Telescope spots the icy building blocks of life swirling around infant stars

News By Robert Lea published March 14, 2024

"This finding contributes to one of the long-standing questions in astrochemistry."

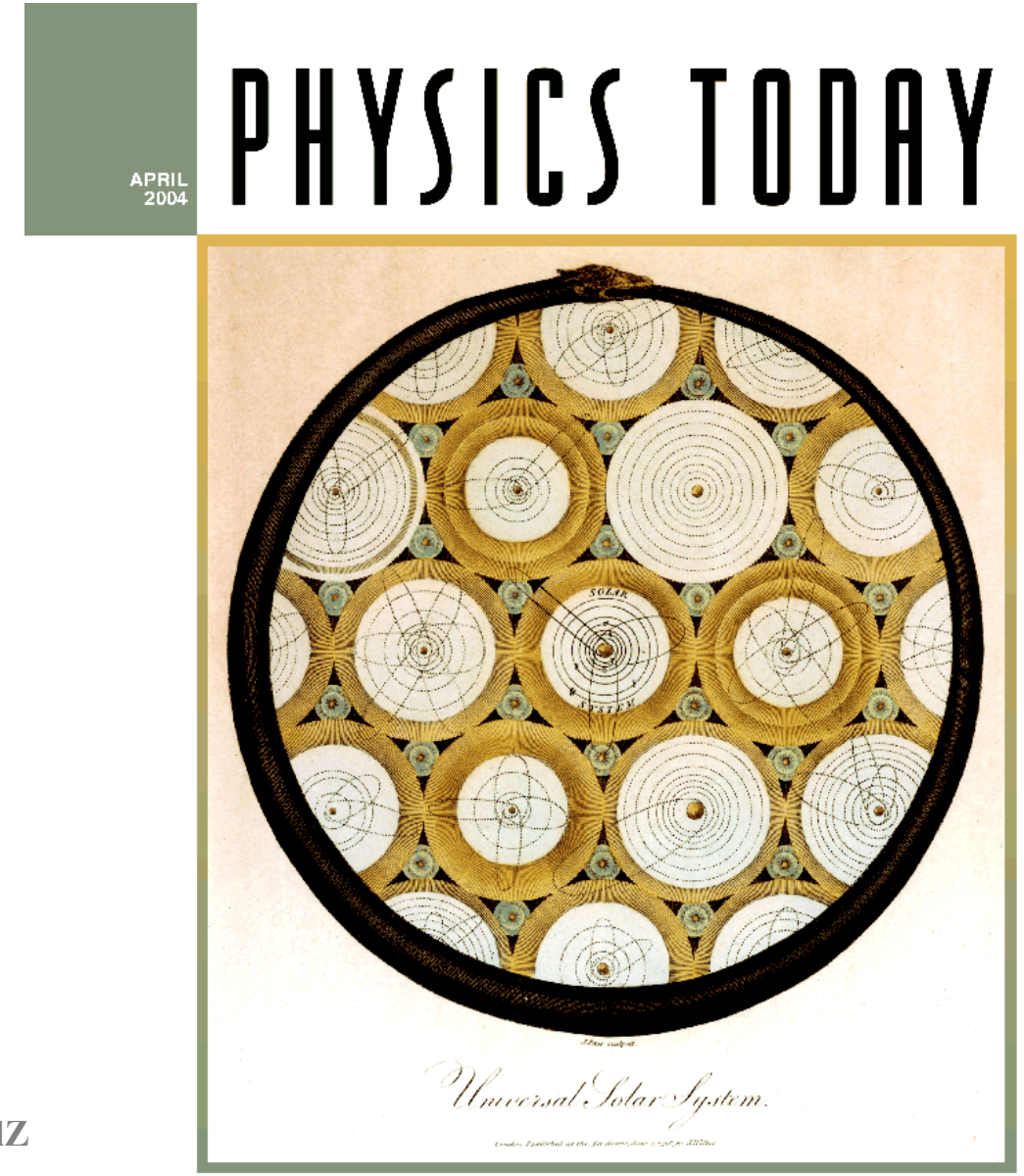
Webb Telescope finds margarita, vinegar and life ingredients in space

This revelation not only tantalises the taste buds but also hints at the fundamental processes that could lead to the birth of habitable worlds.

CBS NEWS

Why NASA is connecting baby stars with margarita ingredients

Diversiteit van planetenstelsels

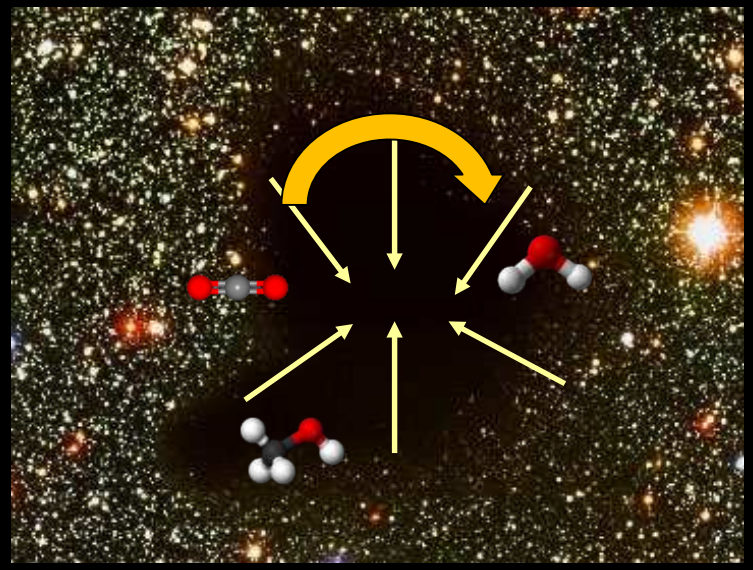


Engelse gravure
John Wilkes, ~1798

Collection EvD+TdZ

Vorming nieuwe sterren en planeten

Ineenstorting wolk

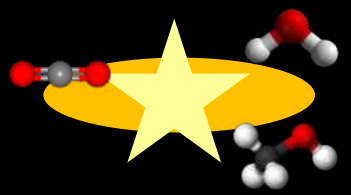


20000 ae

1 ae = Zon-Aarde afstand

Jonge ster met schijf

Factor 400 kleiner



50 ae

Factor 100000 kleiner

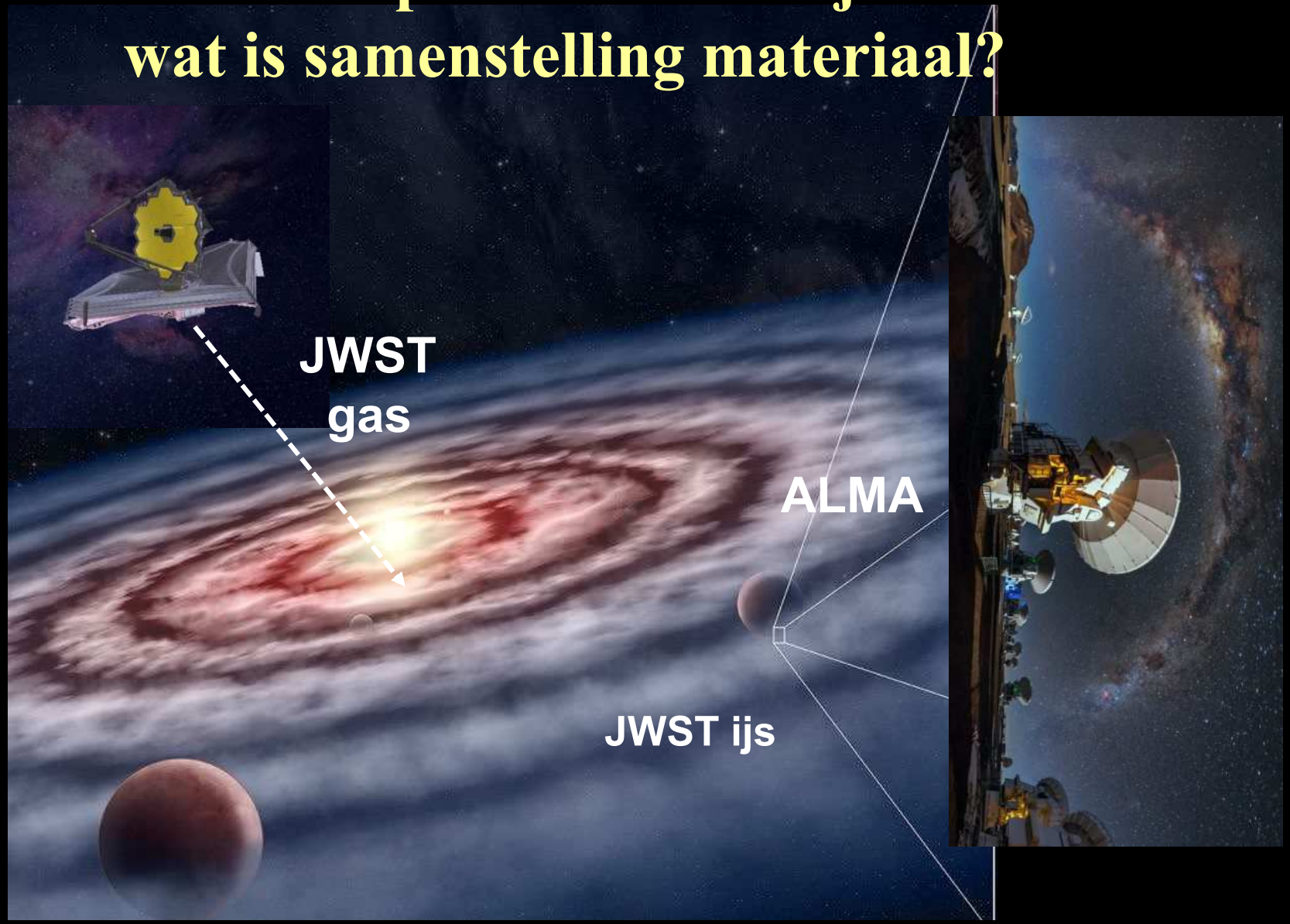
Planeet

Wat zijn de ingredienten voor het maken van nieuwe planeten?

Van stofdeeltjes tot planetesimalen

www.eso.org

Bouwen planeten in schijven: wat is samenstelling materiaal?



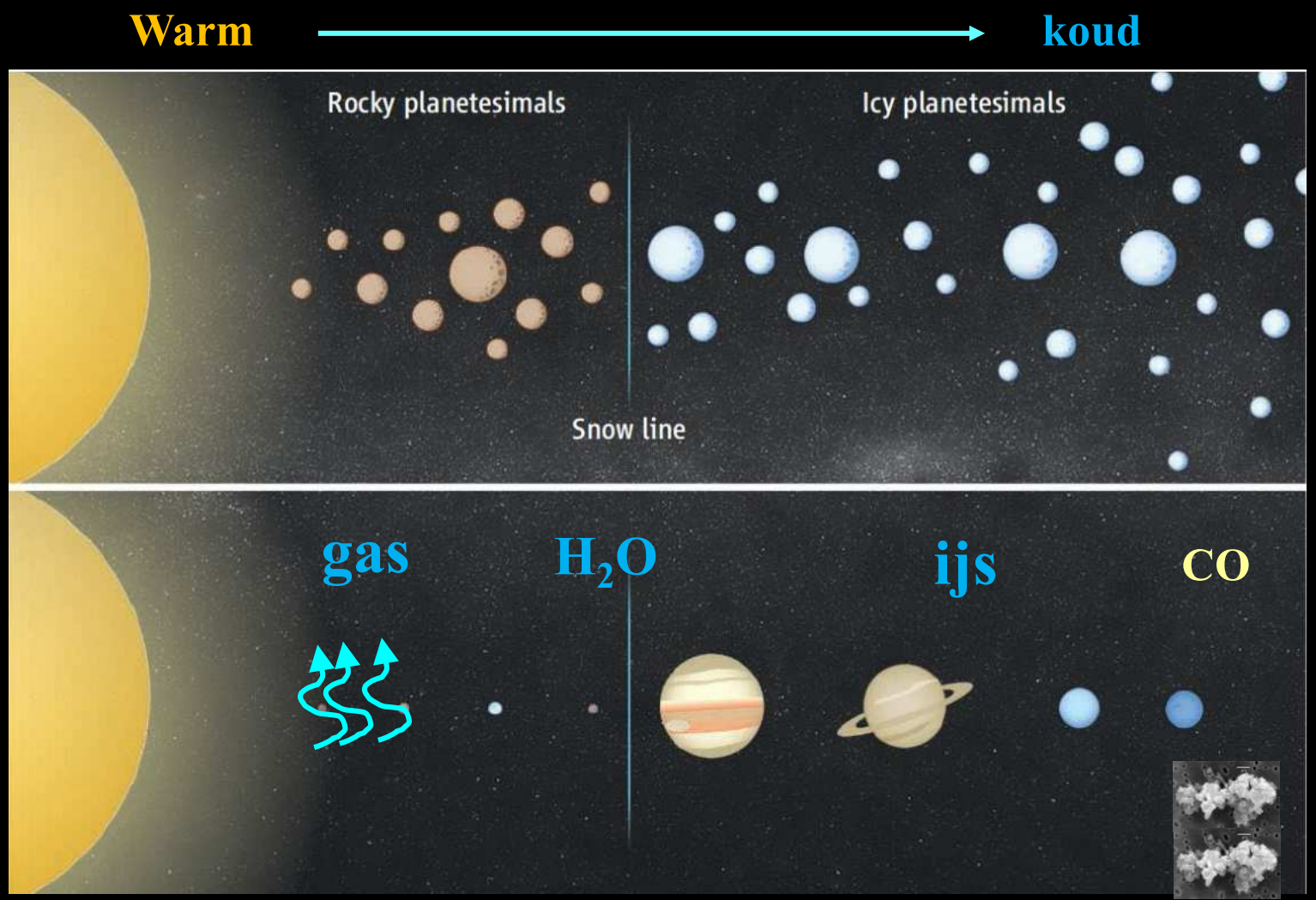
Synergie waarnemingen

M. Weiss, CfA
MAPS Öberg et al. 2021

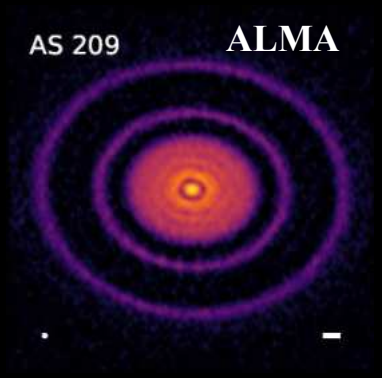
Sneeuwlijnen

50% gas, 50% ijs

Belang water sneeuwlijn



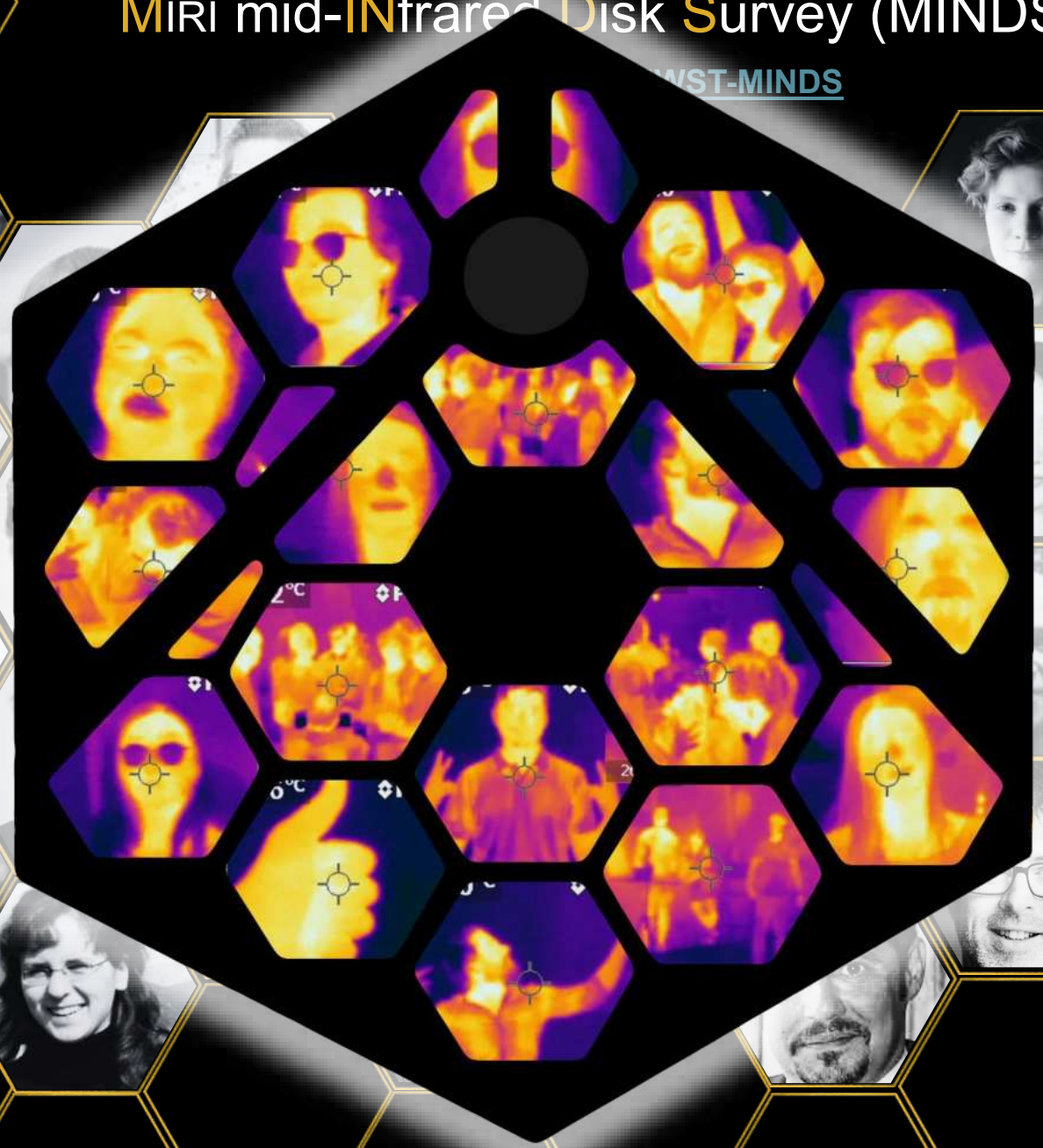
Akeson 2011



Stofval kan voorkomen dat ijzen naar binnen komen

MIRI mid-INfrared Disk Survey (MINDS)

WST-MINDS

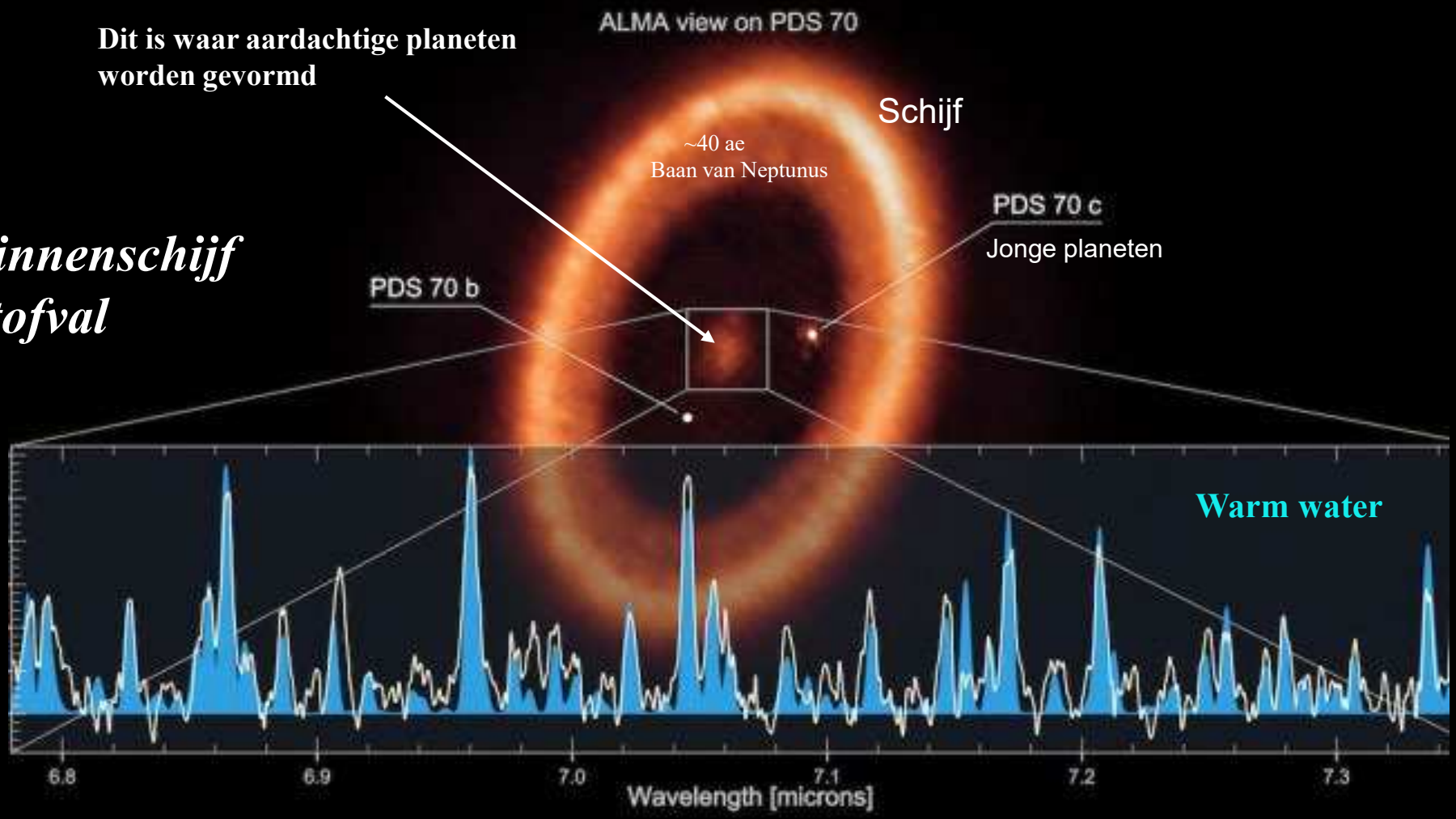


Water bij bouwen aardse planeten

NASA-ESA press release July 24, 2023

Dit is waar aardachtige planeten worden gevormd

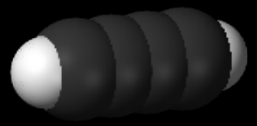
Water in binnenschijf ondanks stofval

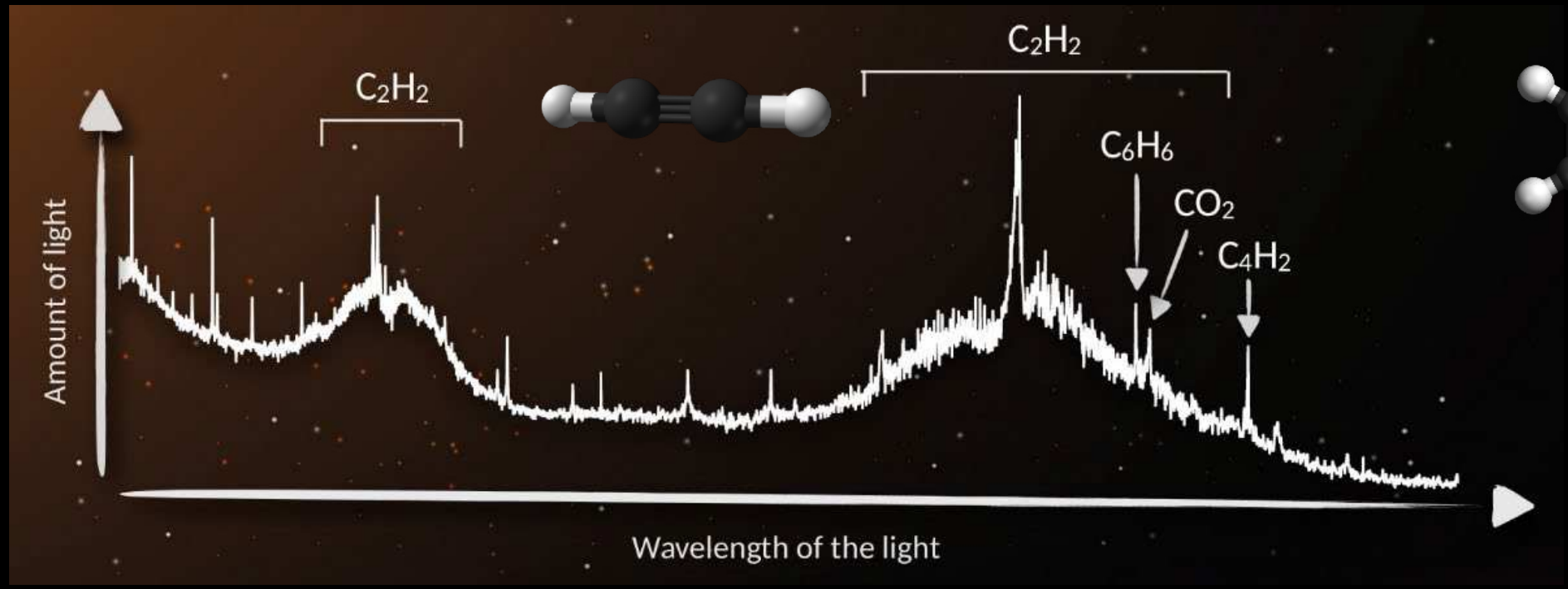


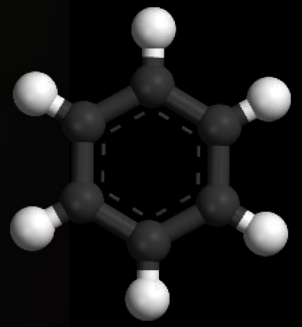
Perotti et al. 2023

Diverse chemie: sommige schijven hebben veel koolwaterstoffen

Hele lage massa ster J160532 <0.2 M_{Sun}







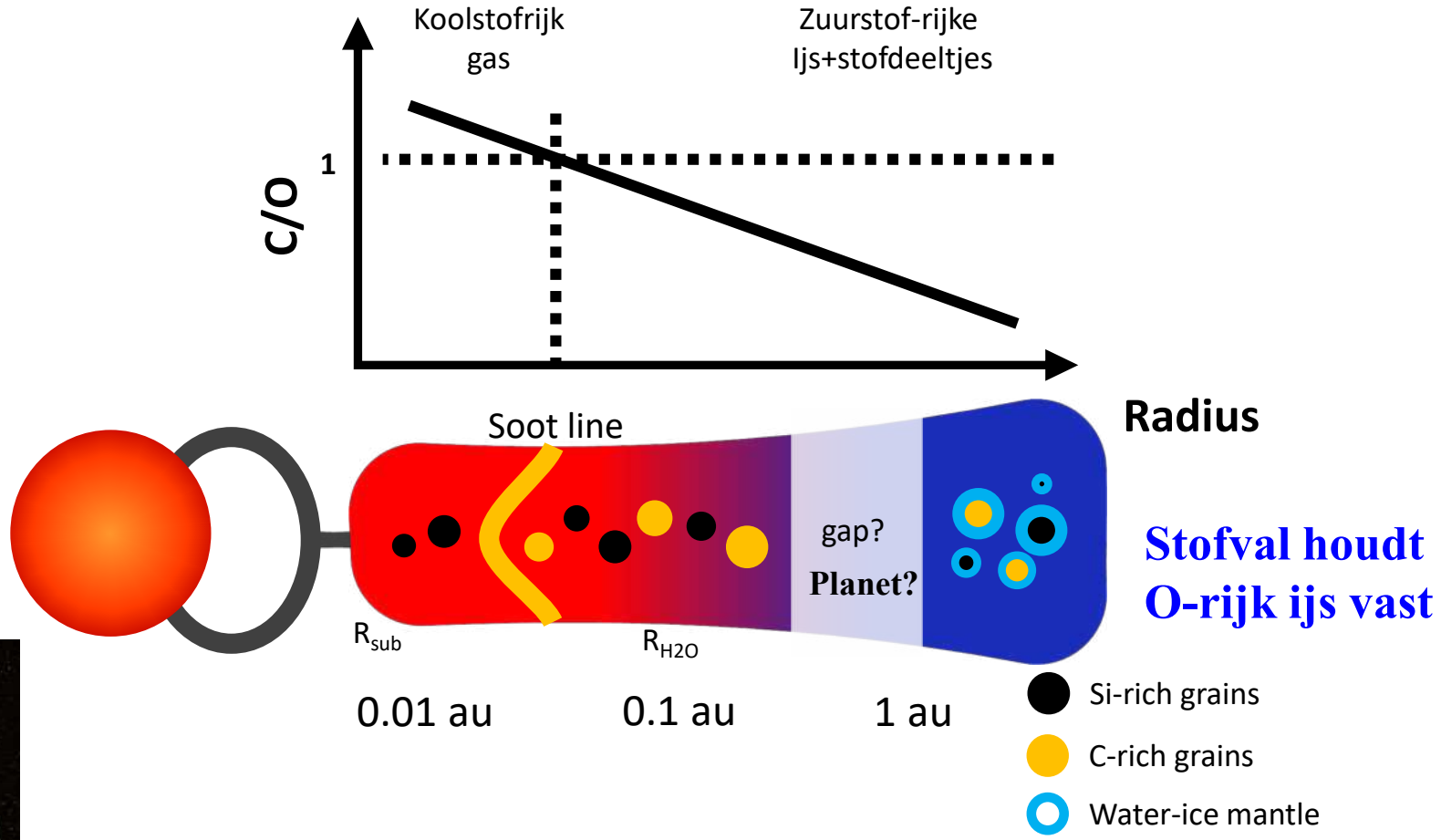
Destructie van koolstofrijk stof bij ~500 K?

Weinig H_2O!

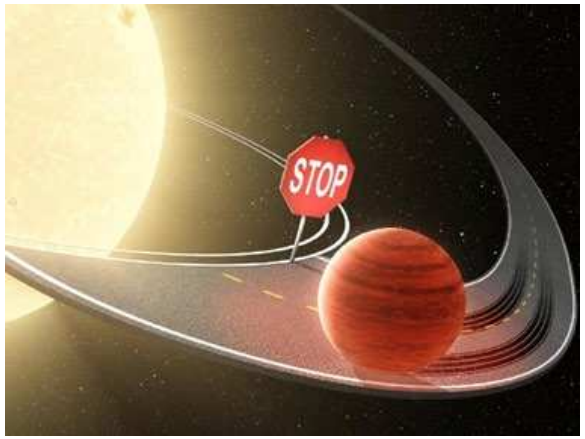
Tabone, Bettoni, vD et al. 2023

Press release May 11 2023

Schets van schijf rond lage massa ster



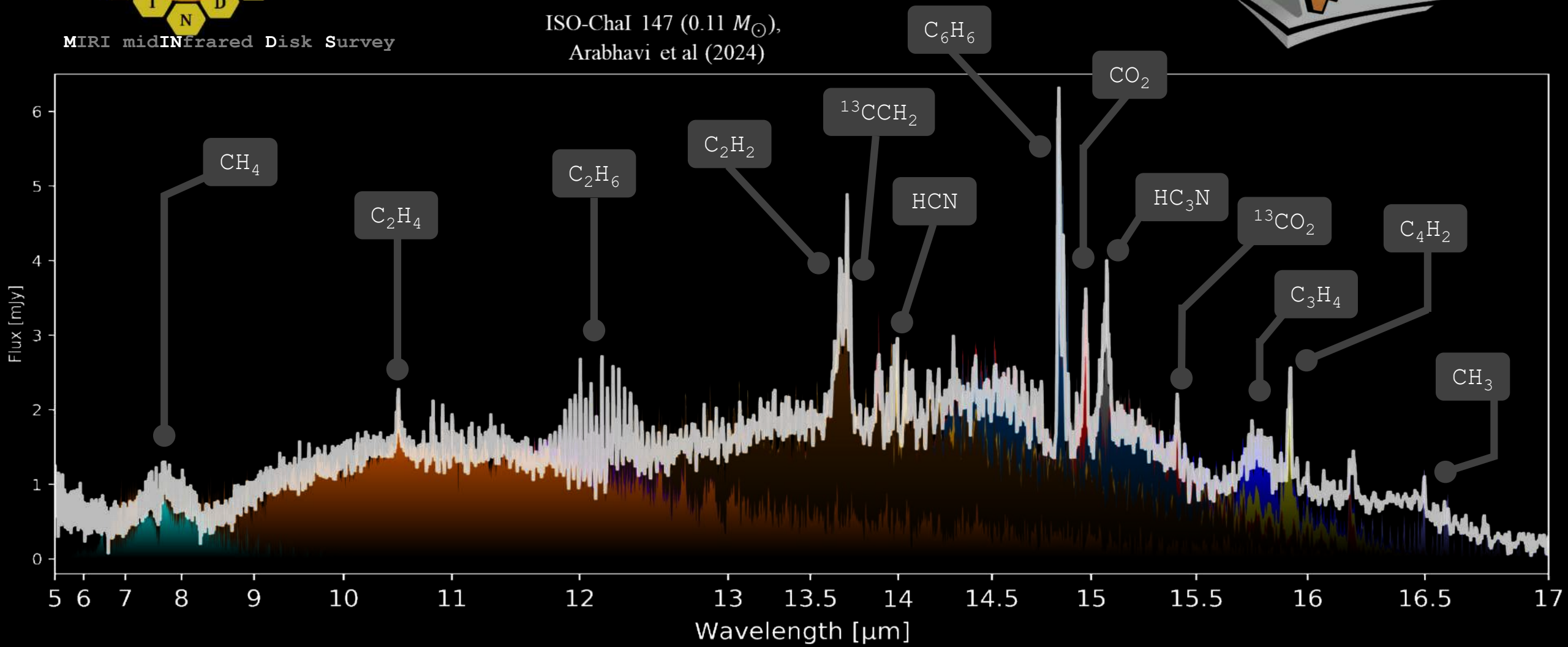
Stofval houdt O-rijk ijs vast



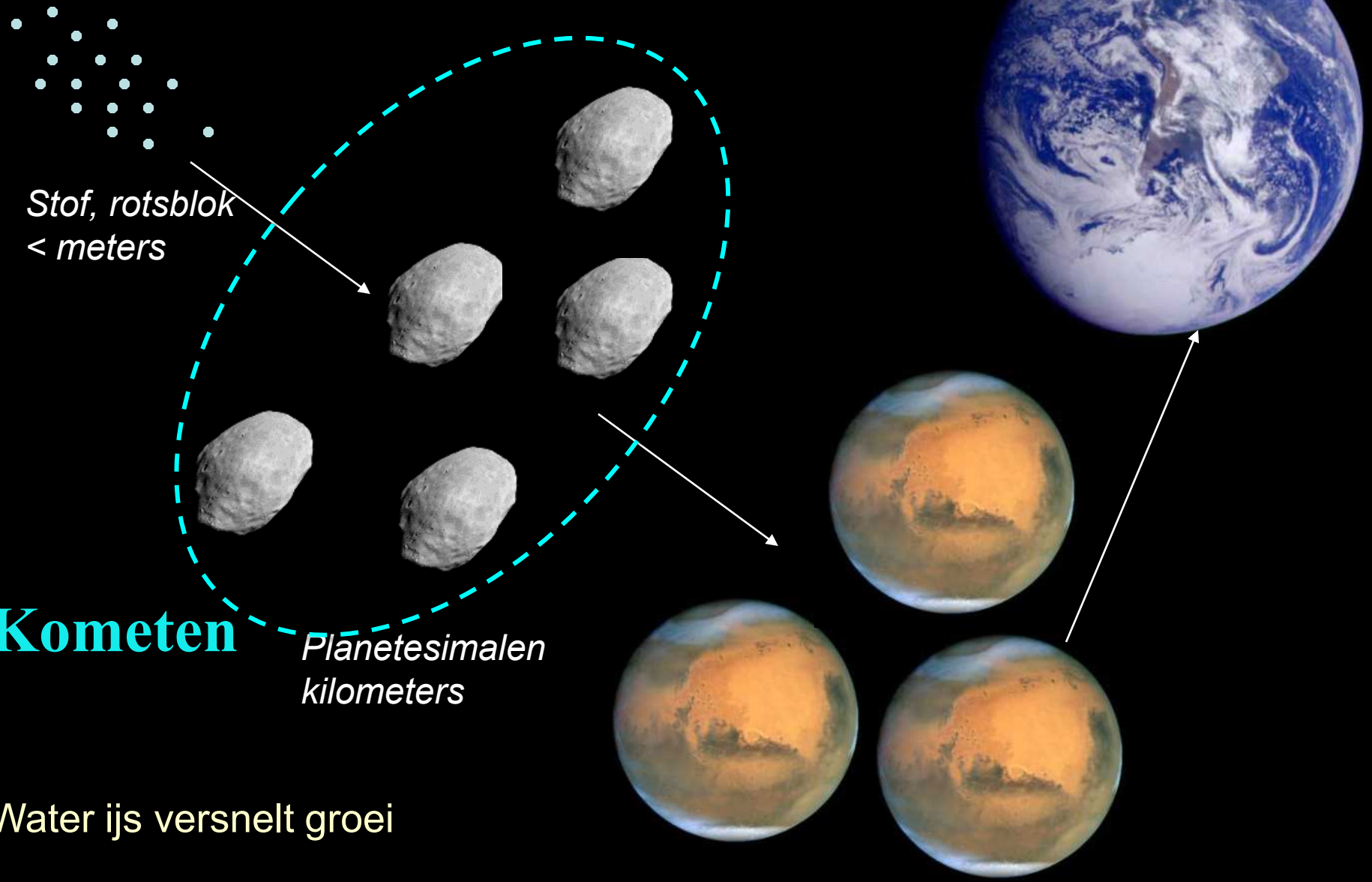
Is dit ook in ons eigen zonnestelsel gebeurd?

Hydrocarbons can be abundant and diverse!

MIRI midINfrared Disk Survey



Van stofdeeltjes tot planetesimalen tot embryos tot planeten



Stof, rotsblok
< meters

Kometen

Planetesimalen
kilometers

Water ijs versnelt groei

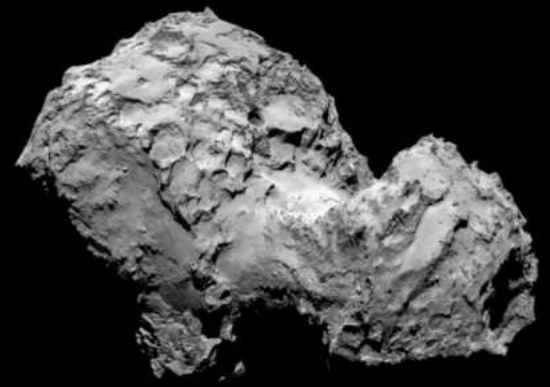
Planeet embryos
Maan (1 AE)-tot-Mars (2 AE) grootte

J. Lunine

Ons eigen zonnestelsel:

Kometen als bouwstenen planeten

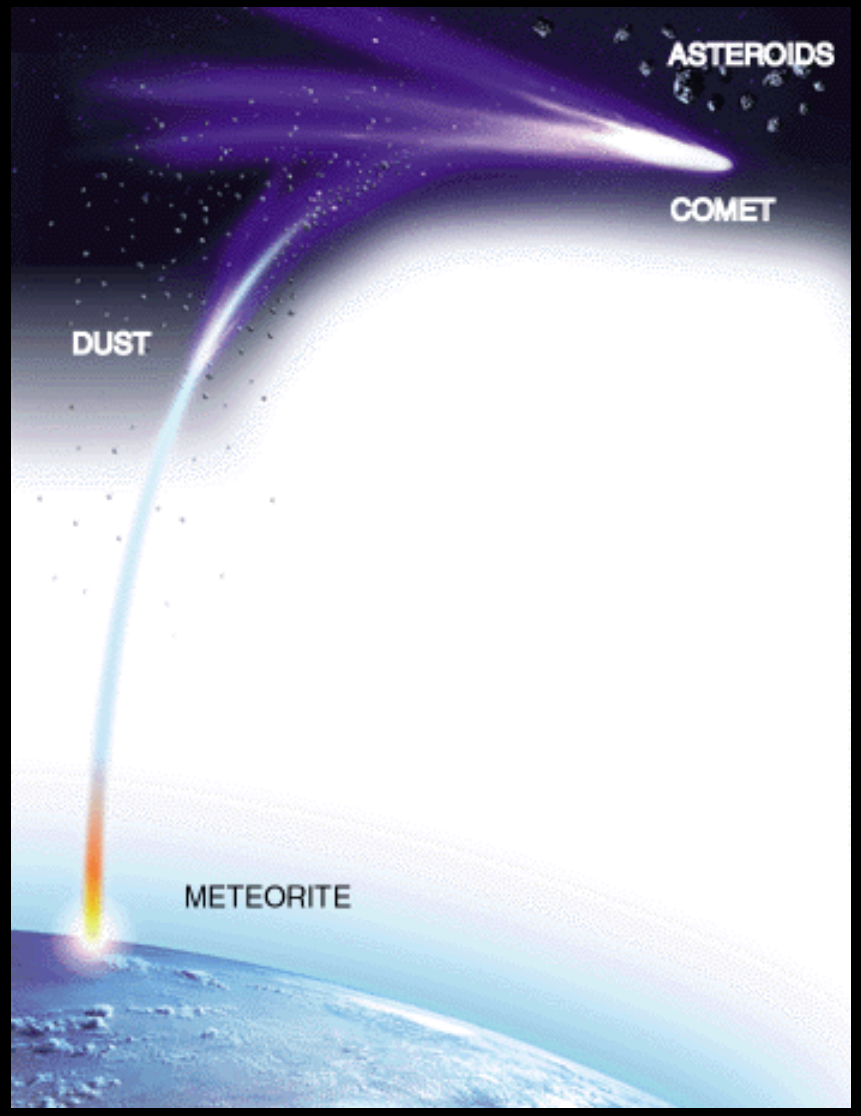
Komeet
Hale-Bopp



Komeet 67P/C-G

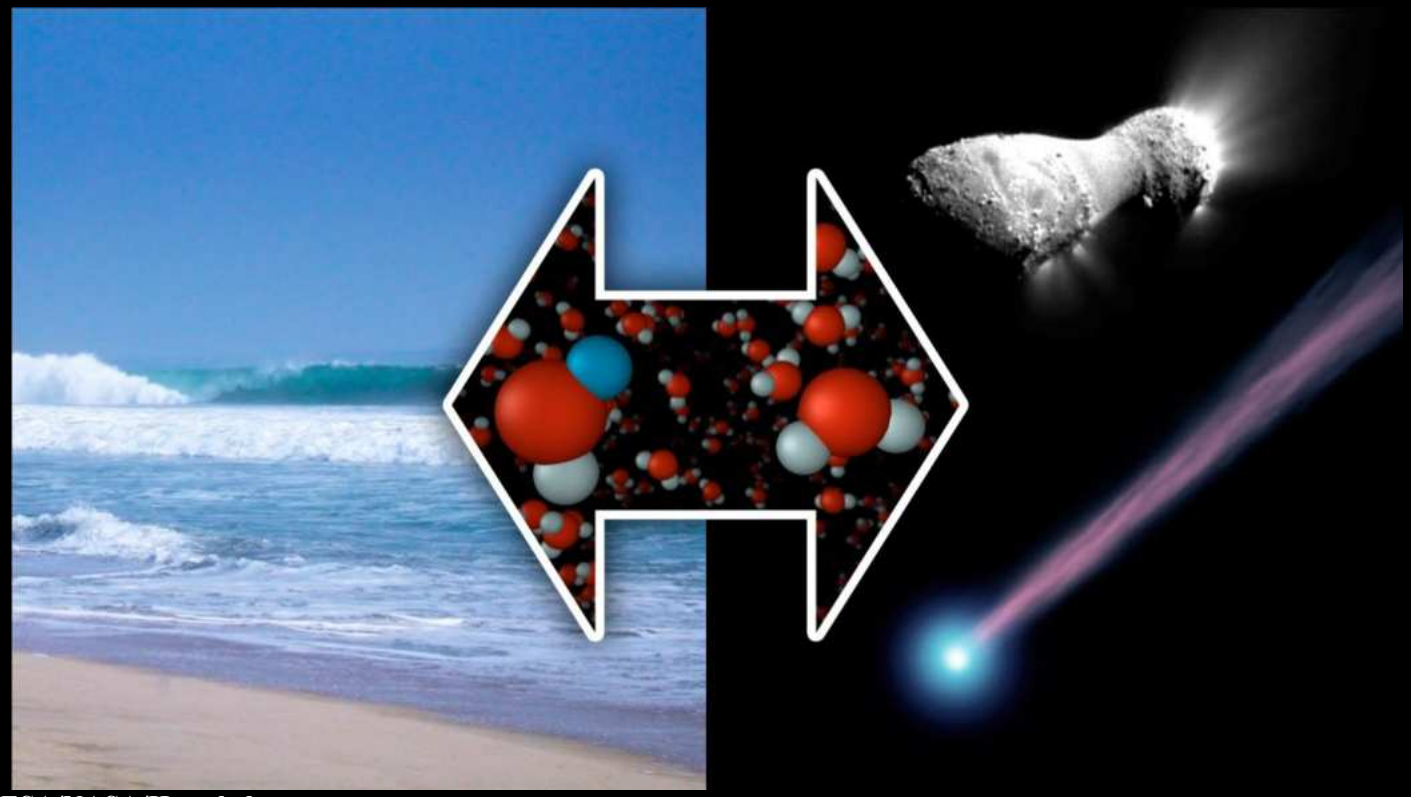
Grote overeenkomst samenstelling komeet en jonge schijf

Kunnen kometen water op nieuwe planeten brengen?



Allamandola et al, Scientific American

Oorsprong water op aarde?

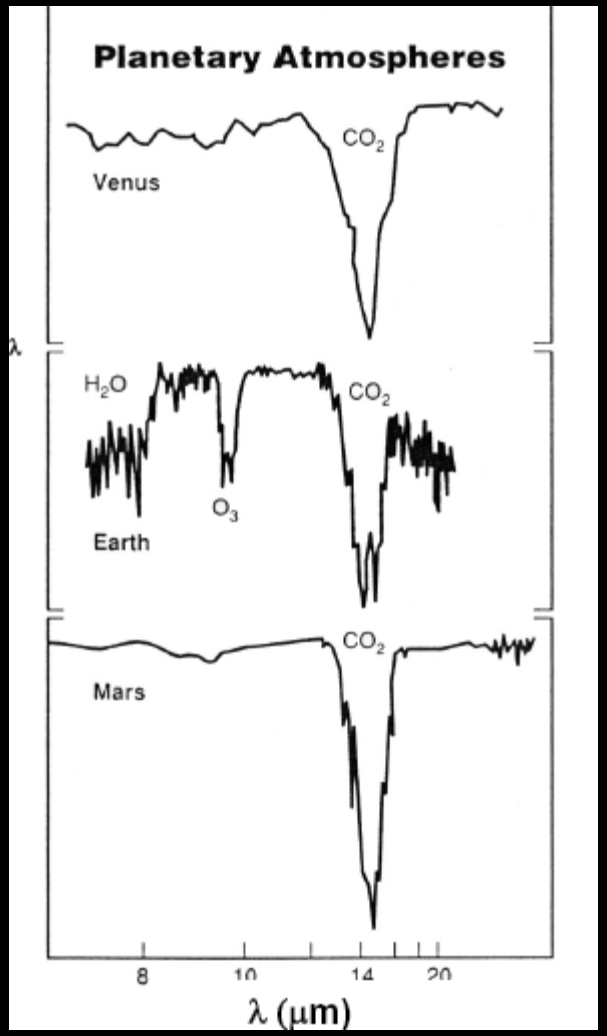


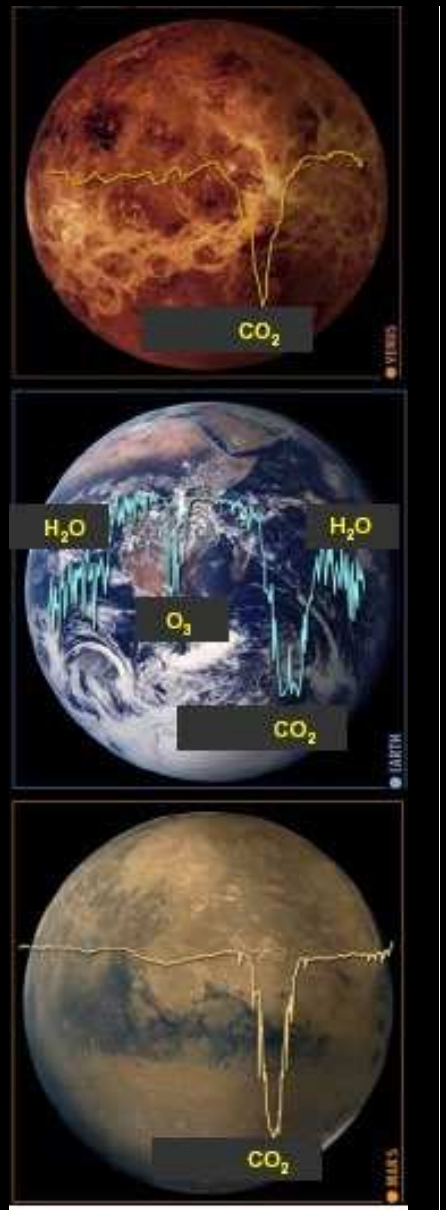
ESA/NASA/Herschel

Zelfde verhouding Oceaan en Komeet: $HDO/H_2O=1.5\ 10^{-4}$

Zon: $D/H=2x10^{-5}$

Kunnen andere planeten bewoonbaar zijn?



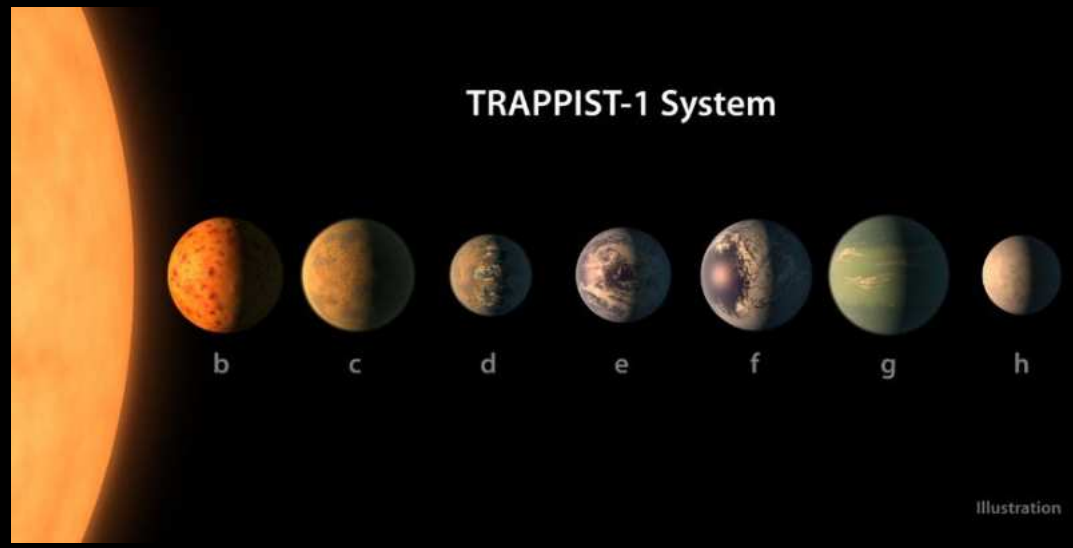


NASA

Aarde ligt in de ‘bewoonbare zone’ met temperaturen waarbij water vloeibaar is

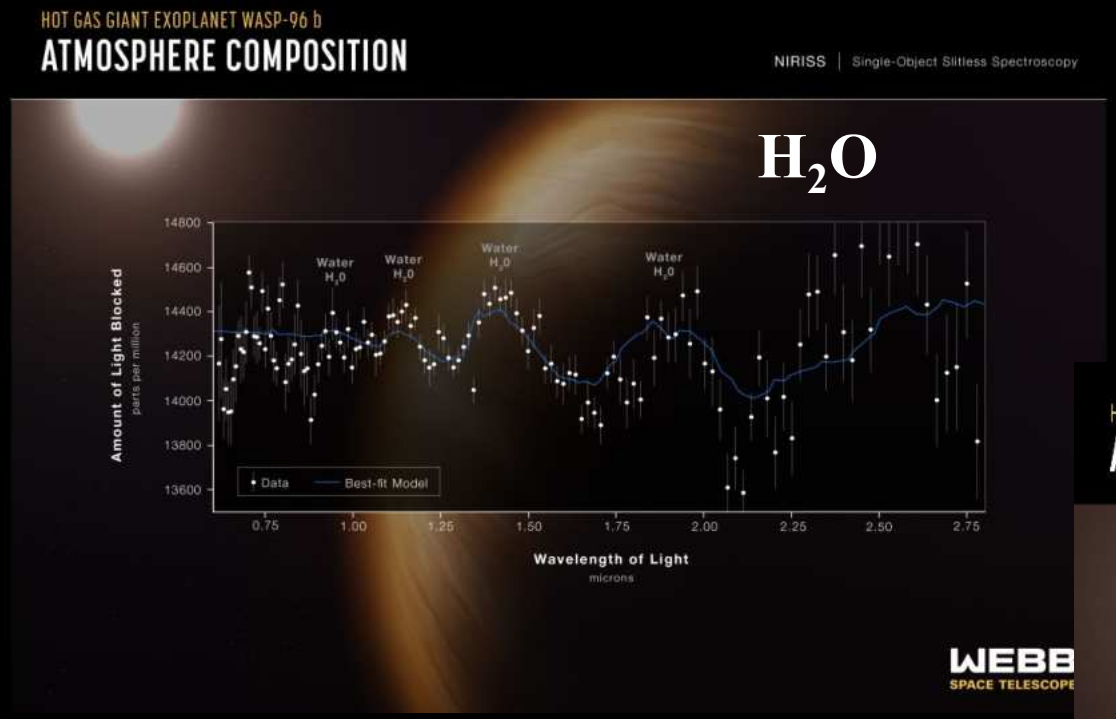
Webb: karakterisen atmosfeer exoplaneten

Dunne atmosfeer laag

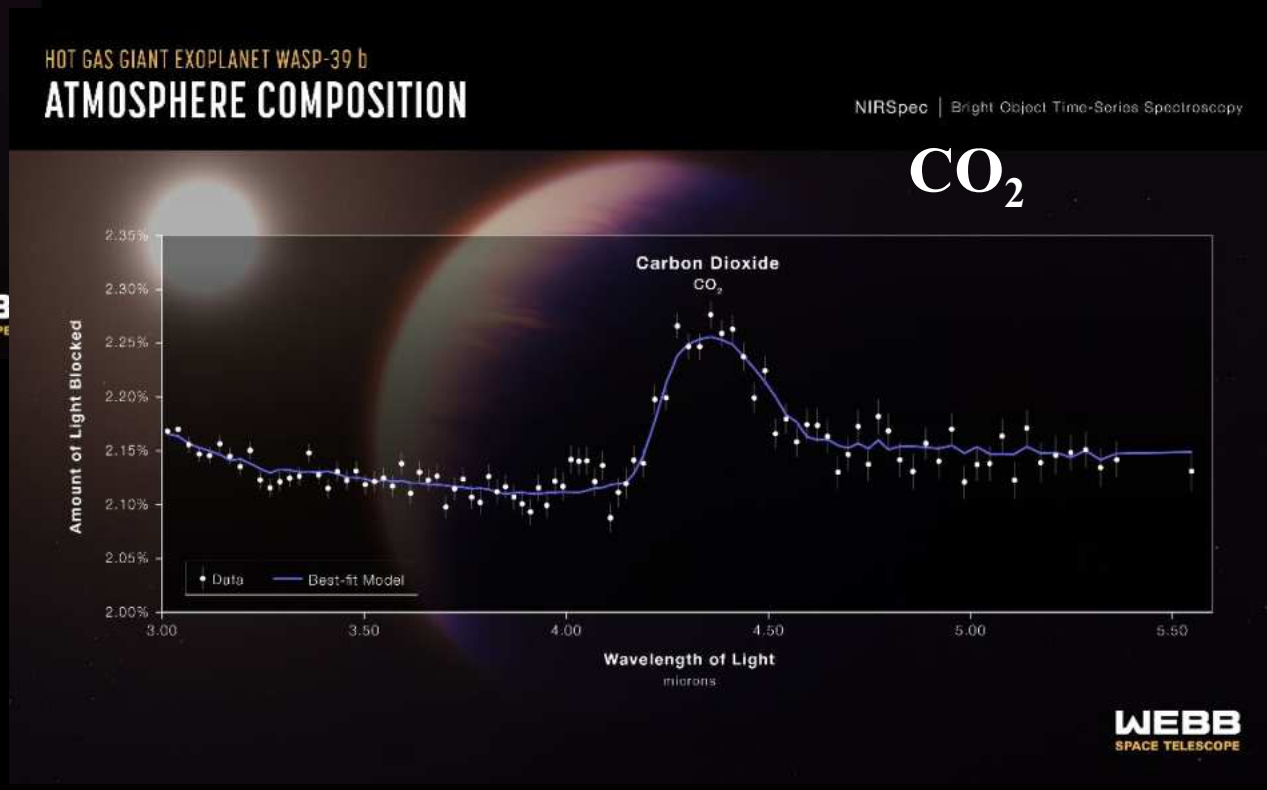


Reuzeplaneten en Aardachtige planeten

Water en CO_2 op exoplaneten

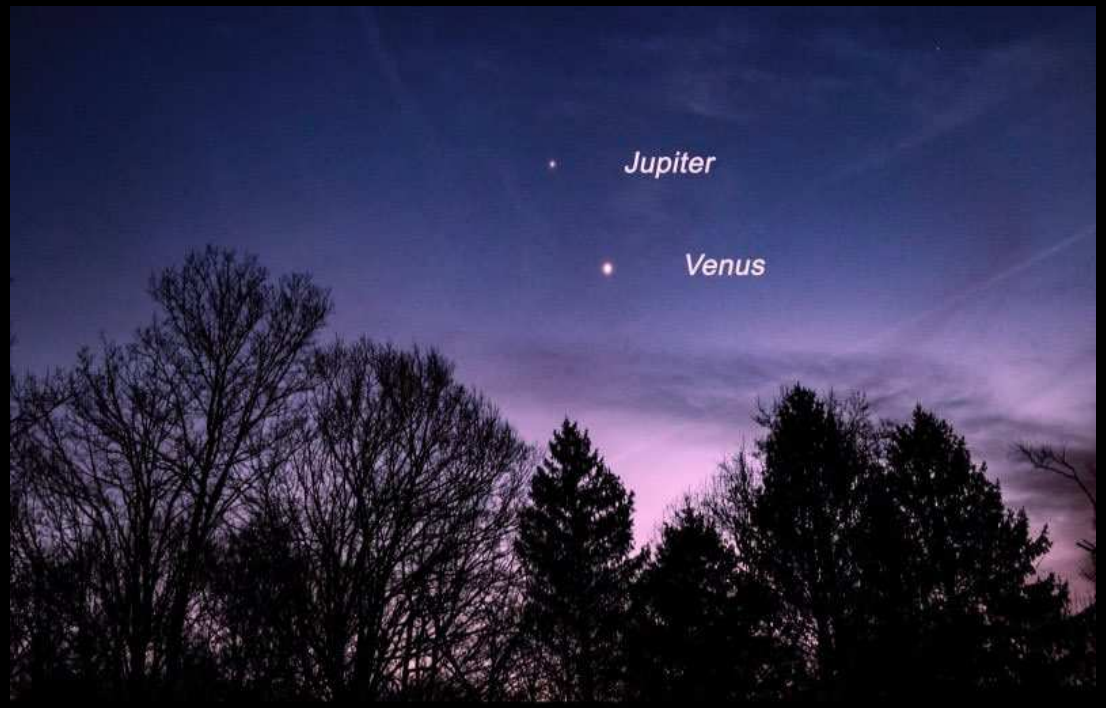


H_2O



CO_2

Twee bekende planeten….



Feb 25, 2023

Conjunctie 2023 1-2 maart

Webb en ons eigen zonnestelsel

Jupiter

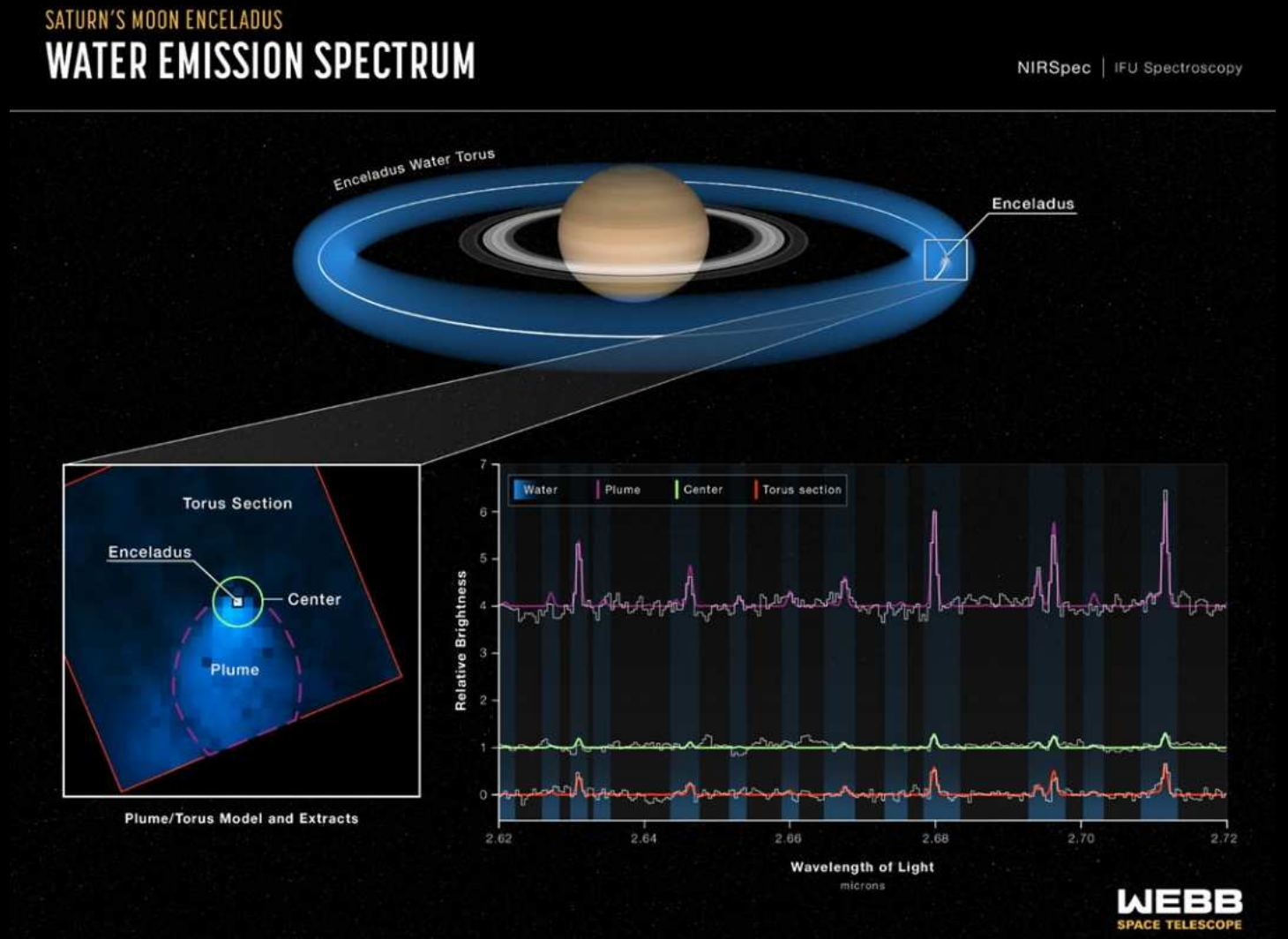
NASA/ESA/CSA/STScI
Judy Schmidt

Saturnus

Uranus

Water en chemie in ons zonnestelsel

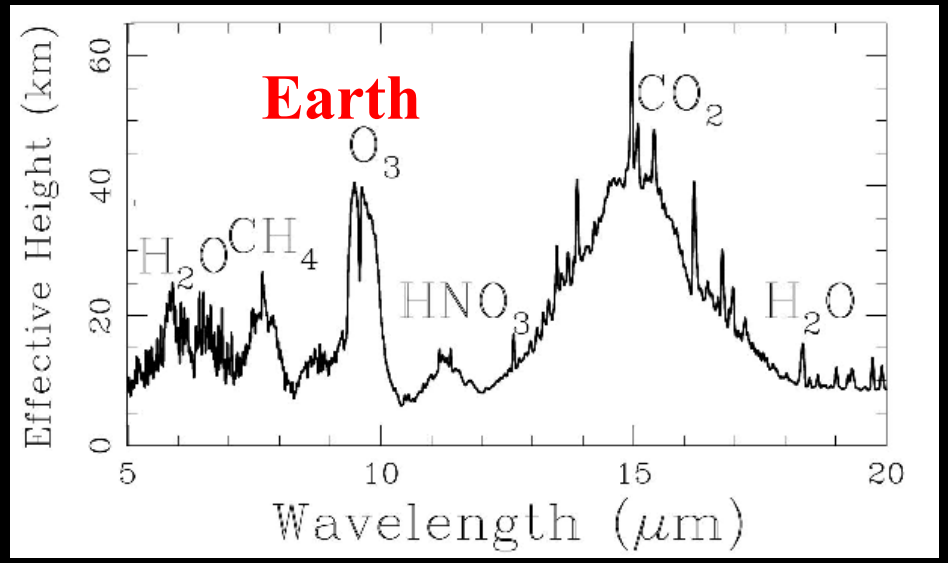
Geisers op Enceladus!



Water en chemie in ons zonnestelsel

Geisers op Enceladus!

Zoektocht naar bio-markers

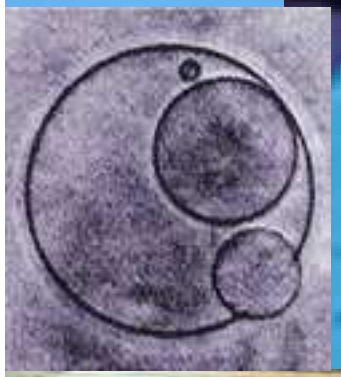


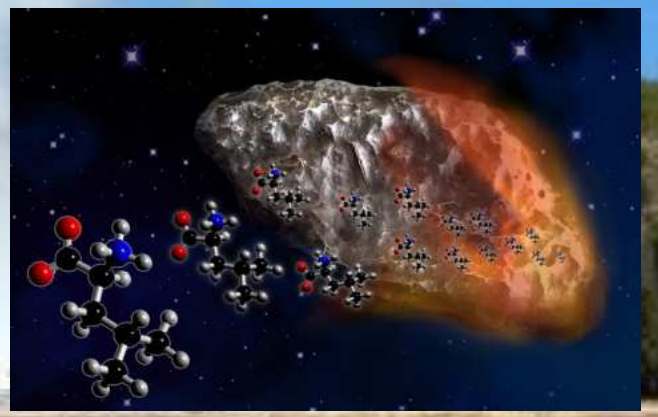
Kaltenegger 2017, ARAA

Proxima b

O_2, O_3, CH_4, N_2O, CH_3Cl, ...
Combinatie oxiderende en reducerende moleculen

Oorsprong van Leven ?





B. Feringa

een astro-chemische odyssey

‘The Mona Lisa of Modern Science’

Samenvatting

- **Moleculen worden overal bij ster- en planetvorming gevonden, in grote hoeveelheden, in gas en ijs *(Webb!)***
- **Planeetvormende zones van schijven kunnen nu in detail worden bestudeerd *(Webb!)***
- **Materiaal kan door inslagen van kometen en asteroiden op nieuwe planeet worden gebracht**
  - **Maar uitkomst niet goed te voorspellen! *Zijn wij uniek?***