

Meteorites in Exoplanet Atmospheres

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Greg Gosselin, Caroline Morley, Sean Gulick



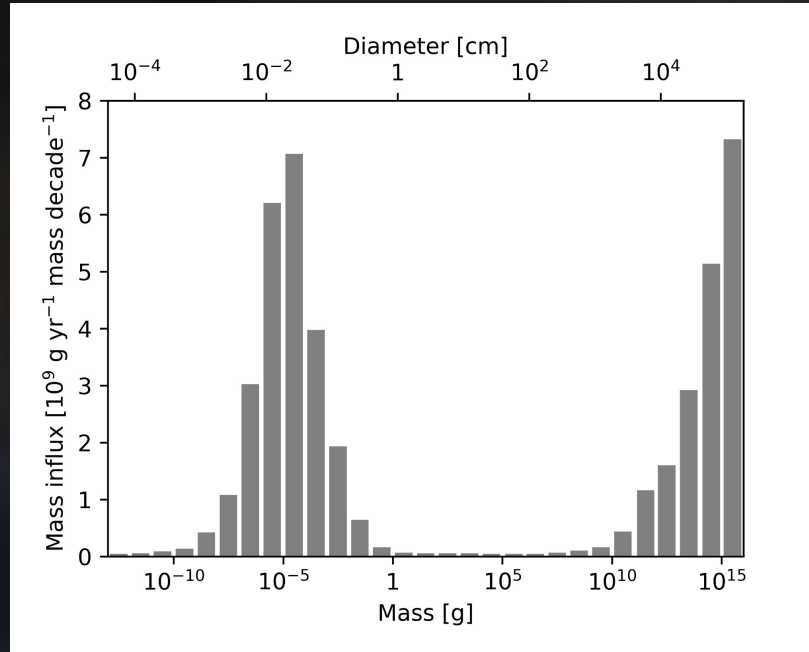
The University of Texas at Austin
Center for Planetary
Systems Habitability



The University of Texas at Austin
Department of Astronomy

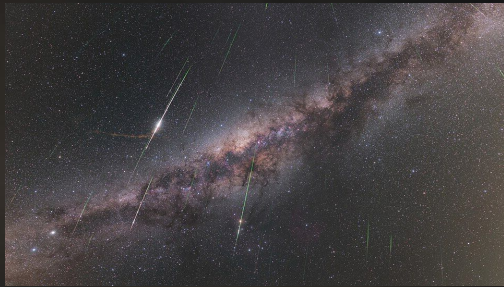
Types of Meteorites

Material infall on Earth



Types of Meteorites

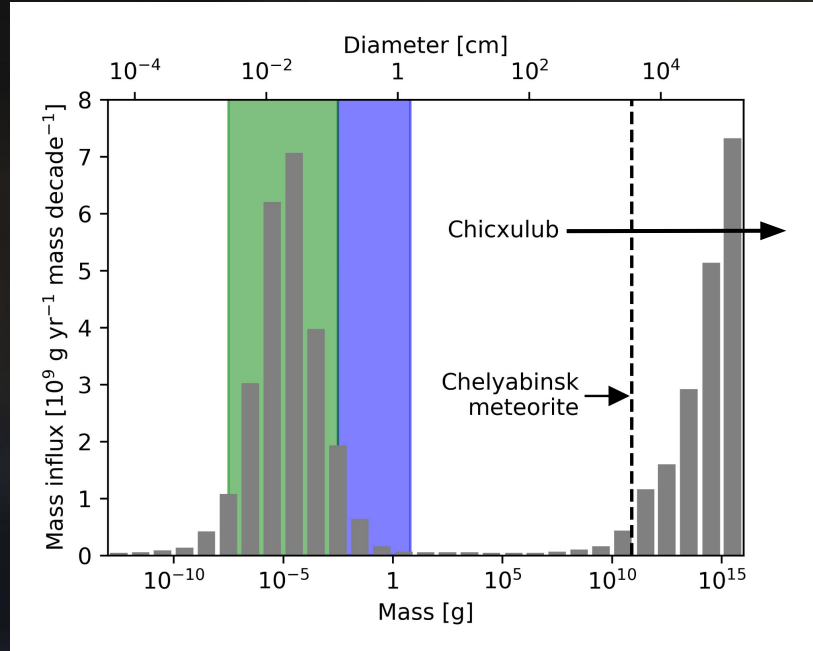
Visible meteorites



Interplanetary dust



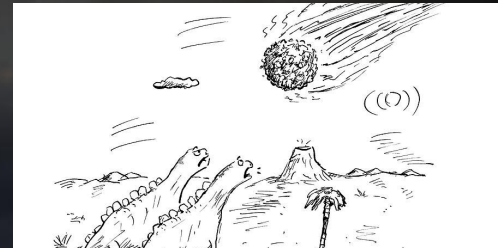
Material infall on Earth



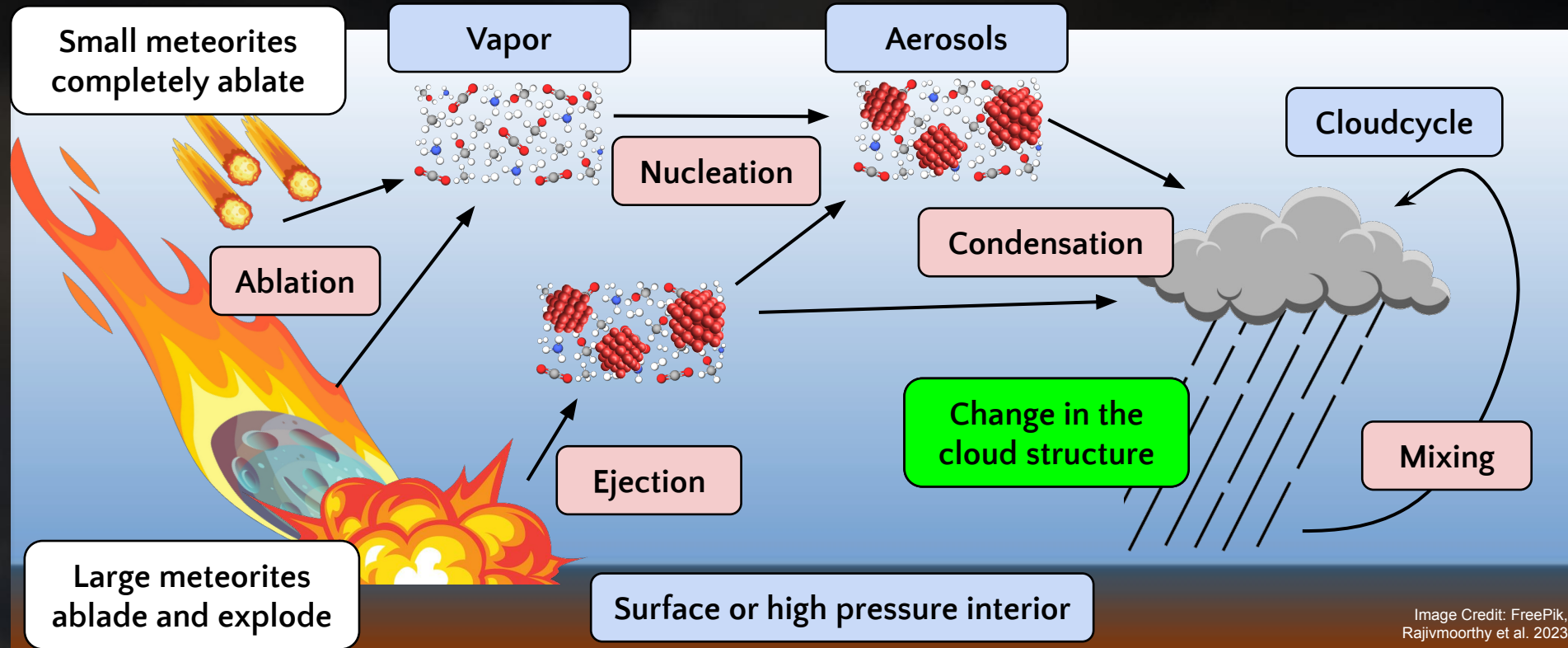
Chelyabinsk



Chicxulub



How do Meteorites affect Atmospheres?



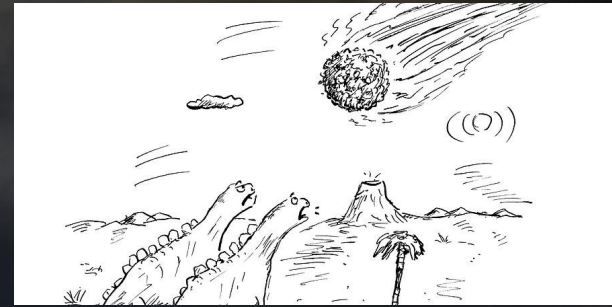
Quiz

Which type of impact do you think is
best observable in exoplanet atmospheres?

Option 1:
Interplanetary dust

Option 2:
Visible meteorites

Option 3:
Large impacts

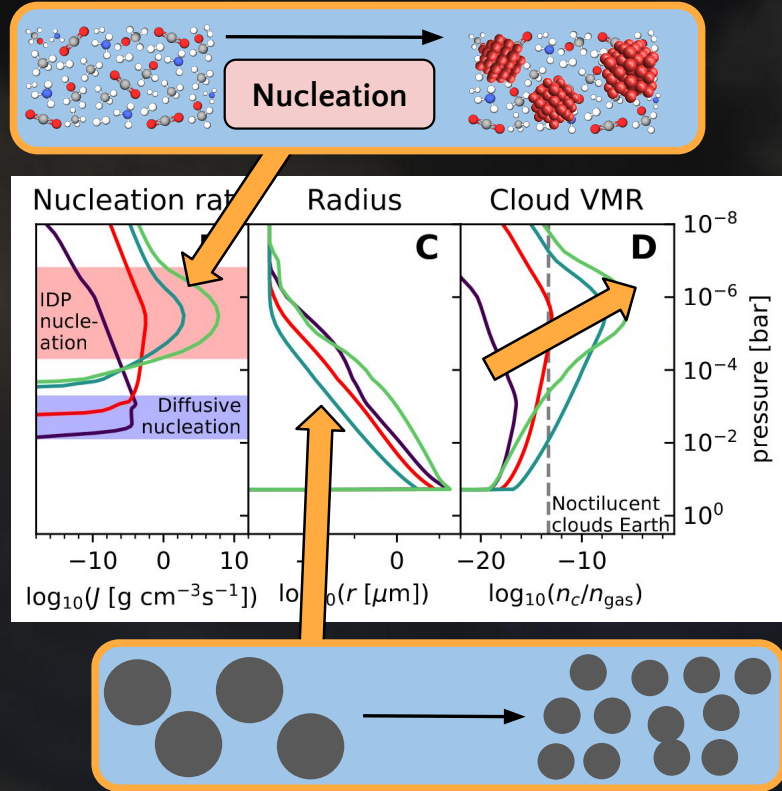


Interplanetary Dust Particles

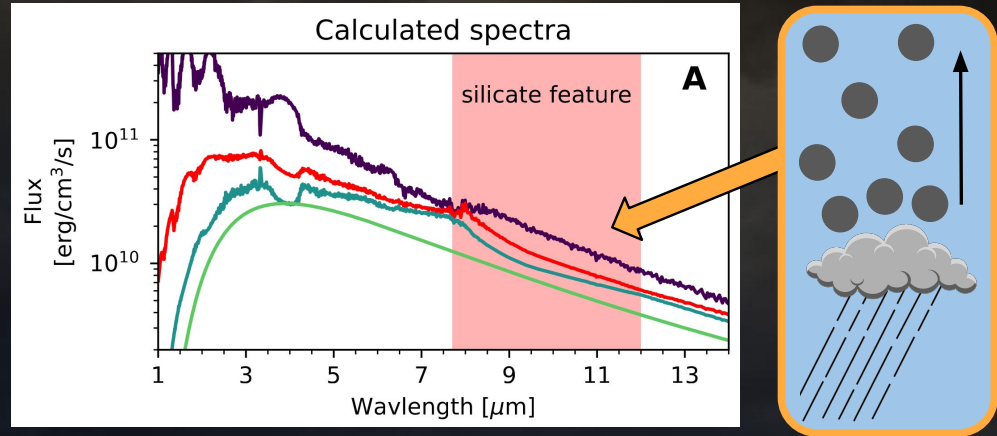


Image Credit: Matthias Süßen

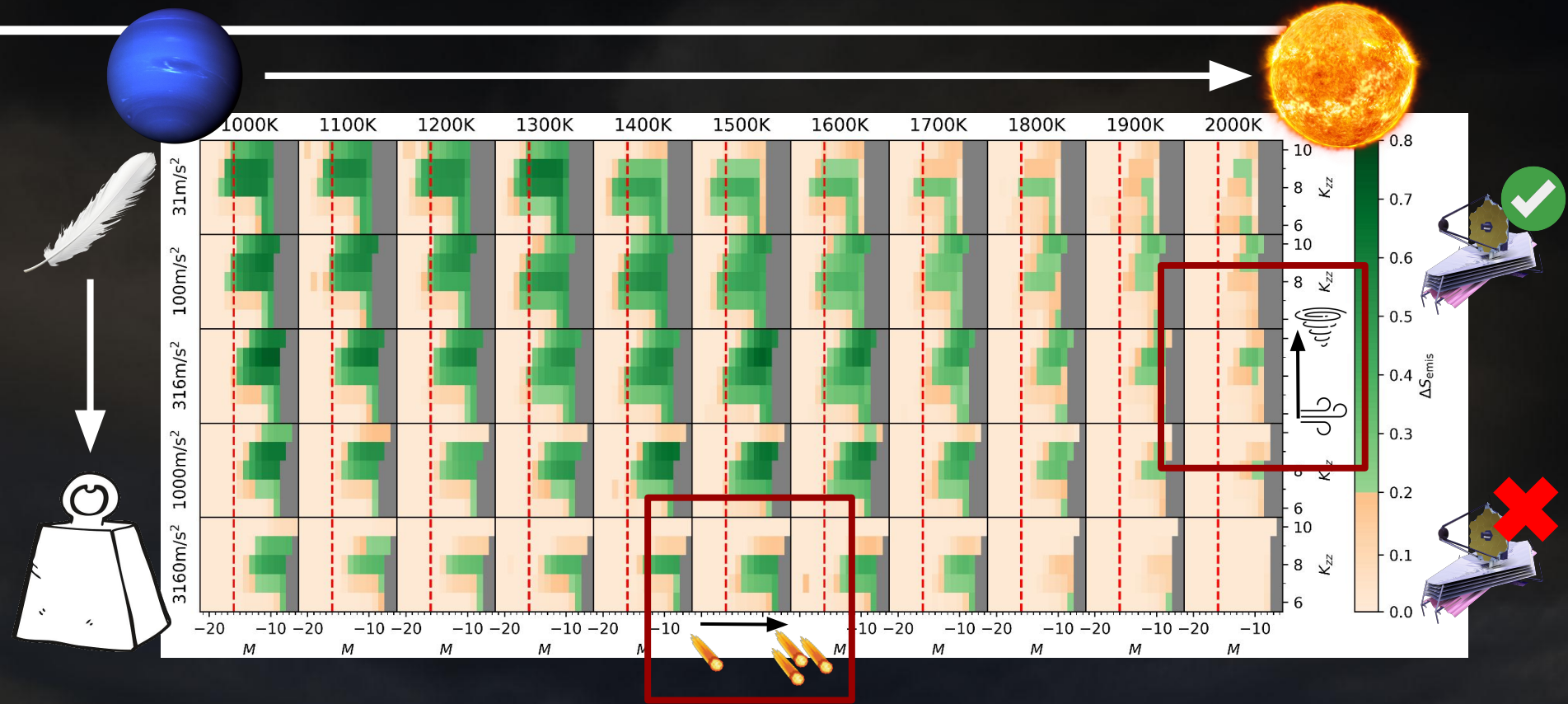
Interplanetary Dust Particles



- We test different amounts of IDPs
- IDPs nucleate high up and replace bottom up nucleation
- More particles lead to smaller particles
- These changes affect cloud features



Interplanetary Dust Particles

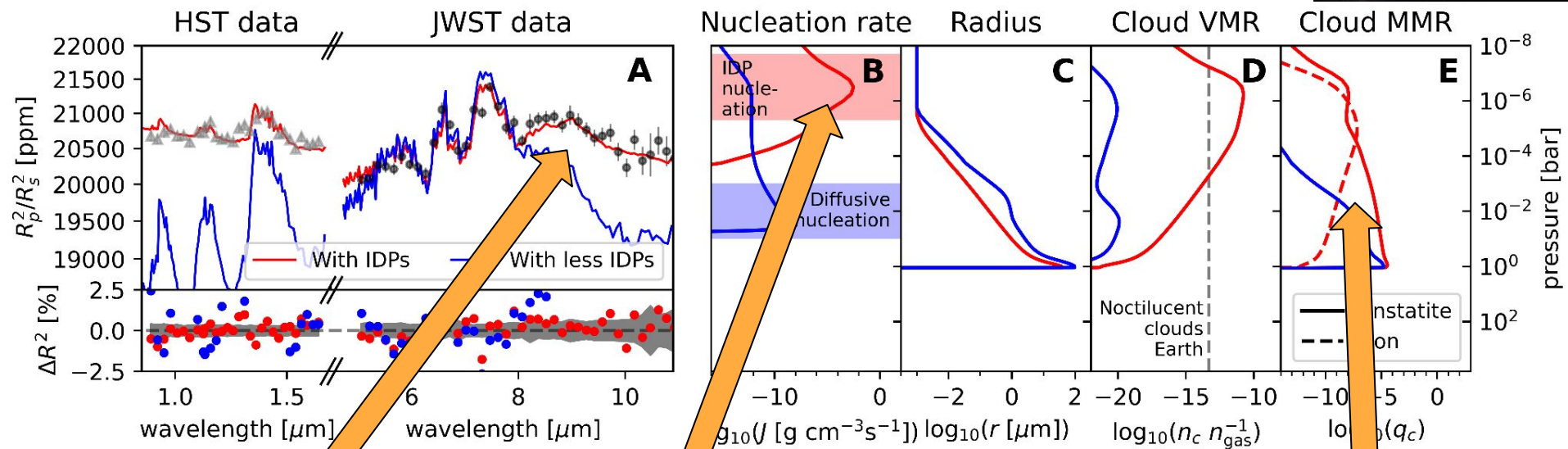
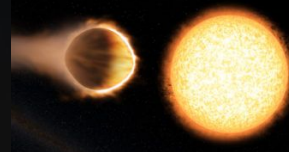




Interplanetary Dust Particles



Interplanetary Dust Particles – WASP 107 b

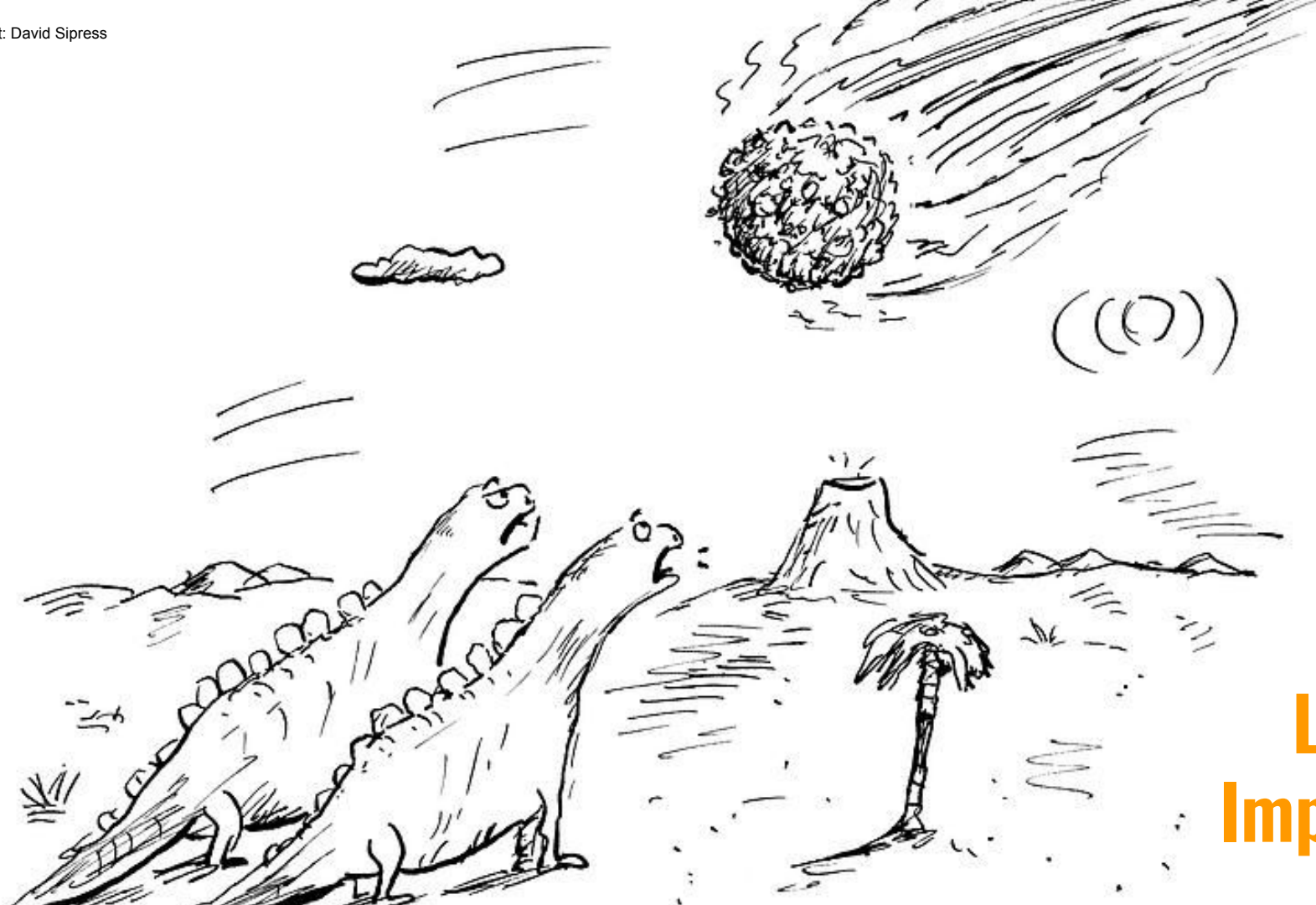


IDPs can explain the silicate features of WASP-107 b

IDPs dominate the production of new cloud particles

IDPs lead to more cloud particle from the interior reaching up

Image Credit: Engine House VFX, At-Bristol Science Centre, University of Exeter



**Large
Impacts**

Large Impacts

How often do large meteorites impact?



Chelyabinsk ↓

↓ Chicxulub



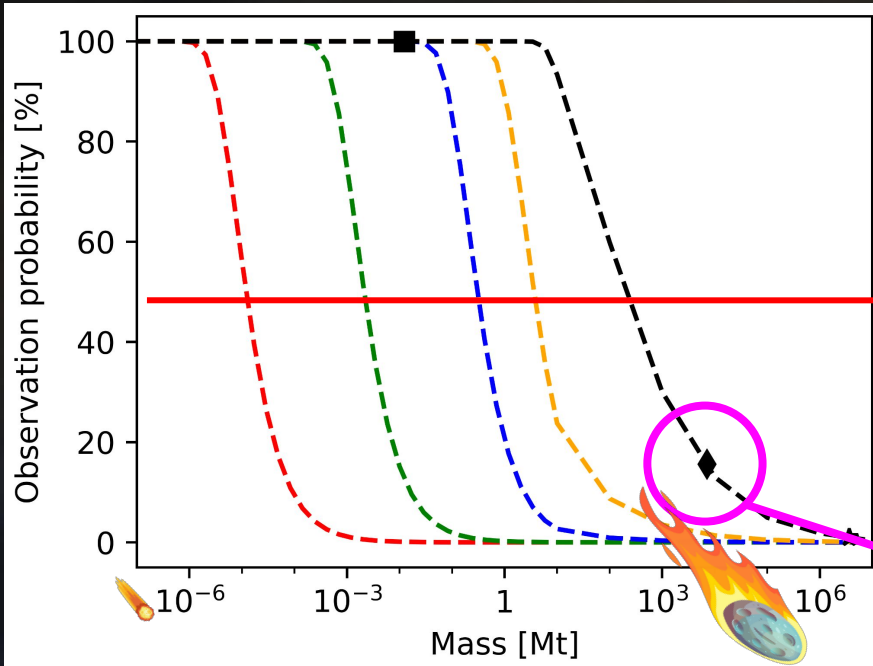
Earth

+ larger (Jupiter sized)

+ young system

+ high metallicity

+ 10 observations



Likely to be observed

Not likely to be observed

Shoemaker-Levy 9 on Jupiter

The real problem: Surface area

- Shoemaker-Levy 9 covered 10° latitude
- The remnants lasted roughly 2 months

Exoplanets are not resolved, so all contributions are mixed

Image Credit: ESA

The real problem: Surface area

Exoplanets are smaller than a single pixel

- Shoemaker-Levy 9 covered 10° latitude
- The remnants lasted roughly 2 months

Exoplanets are not resolved, so all contributions are mixed

- SL9 signal is suppressed by a factor of 40
- JWST (\$10B) added a factor of 10
- Not impossible but very difficult on top of an already rare event

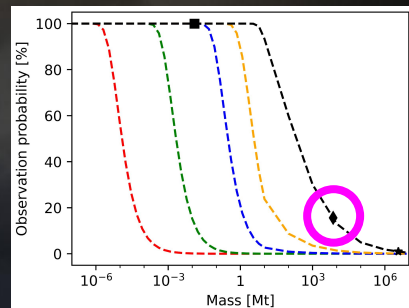
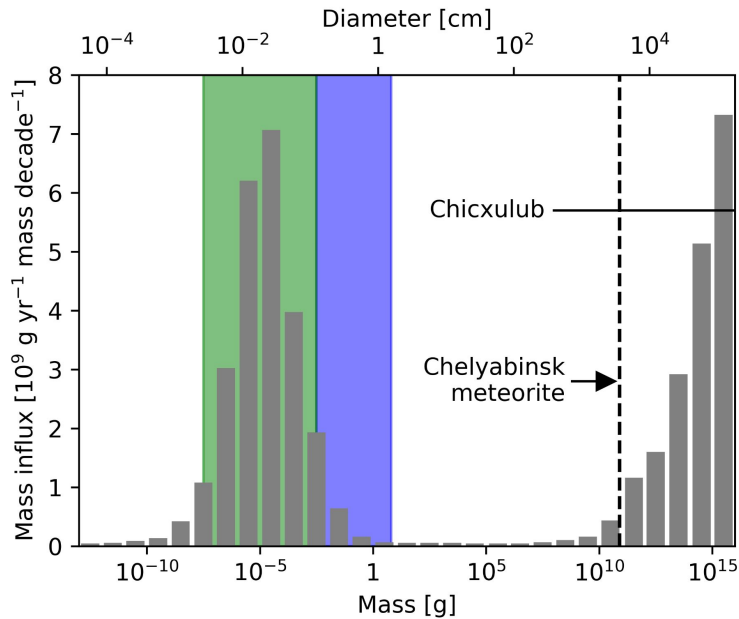


Image Credit: Marois & Wang

Visible Meteorites



Visible Meteorites



- Less material than IDPs
- Light flashes are very brief ($< \text{seconds}$)
- Even large impact flashes last only seconds

In exoplanet atmospheres, visible meteorites are less observable than IDPs

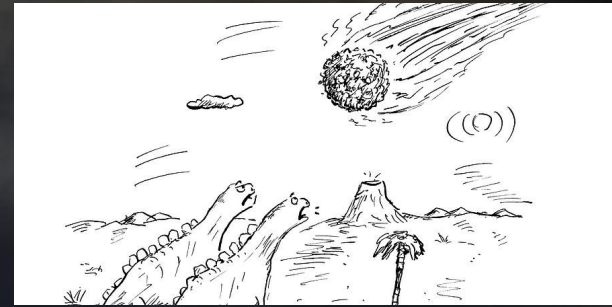
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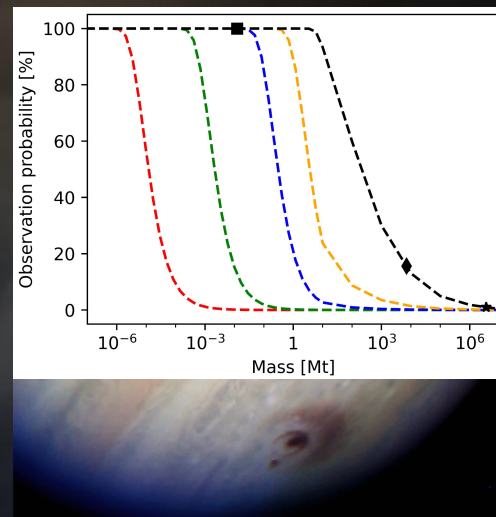
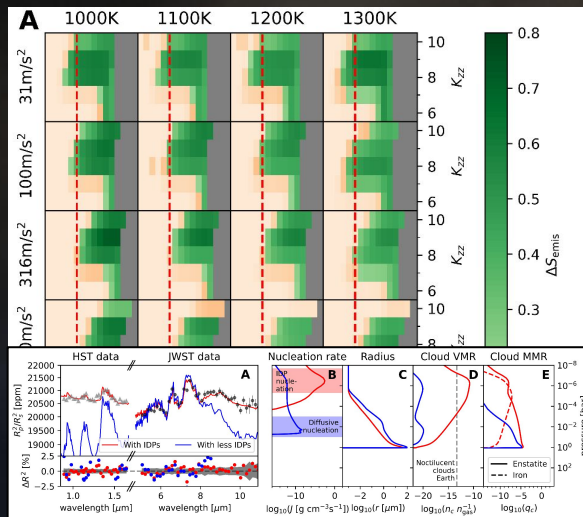


Meteorites in Exoplanet Atmospheres

Vapor and dust from meteorites seeds cloud formation

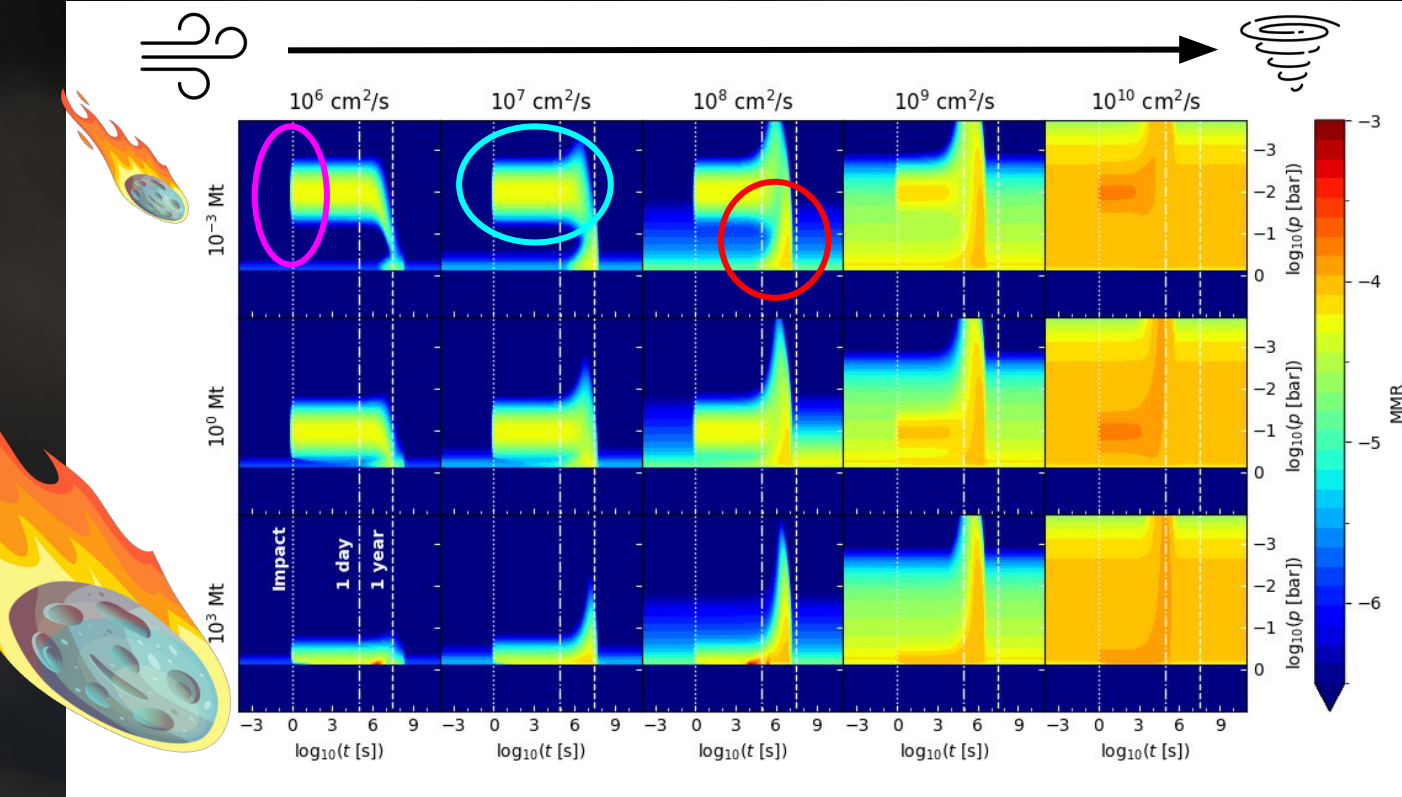
Small continuous infall of IDPs is observable in exoplanet atmospheres!

Large impacts on exoplanets are difficult to observe



Additional Slides

Simulations of Large Impacts

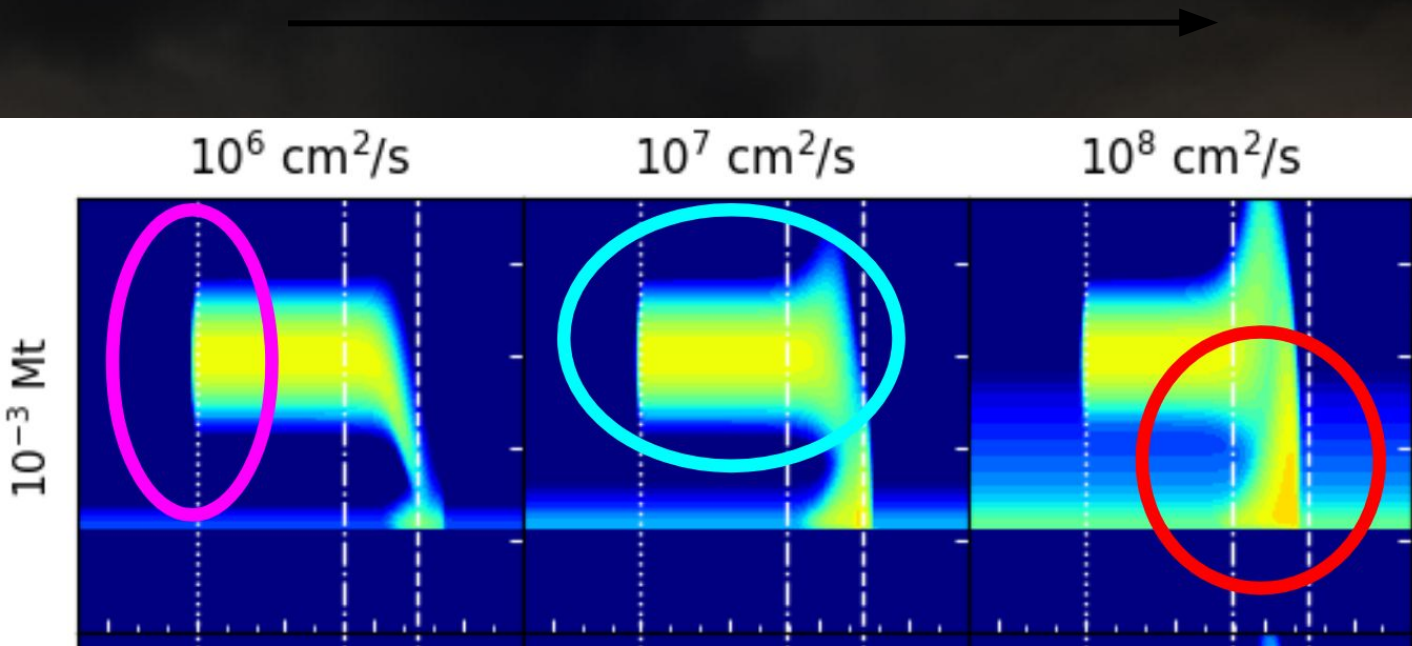


On Impact:
Additional material
blocks the view

> 1 week:
Impact cloud
diffuses

< 1 year:
Cloud structure is
affected

Simulations of Large Impacts



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