GISMO

(*G*iant *I*R and *S*ub*M*m *S*pace *O*bservatory)

by

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WHY BUILD A GIANT FIR/subMM SPACE TELESCOPE?

- Fir/subMM? (difficult)
- GIANT? (expensive)
- SPACE? (expensive AND difficult)

FIR/subMM? (difficult)

- Much of the electromagnetic radiation by which we must study the Universe is in the FIR/subMM:
  - Distant objects are redshifted → We see them better in the IR
  - Most astronomical systems have lots of DUST in them → Visible light is blocked

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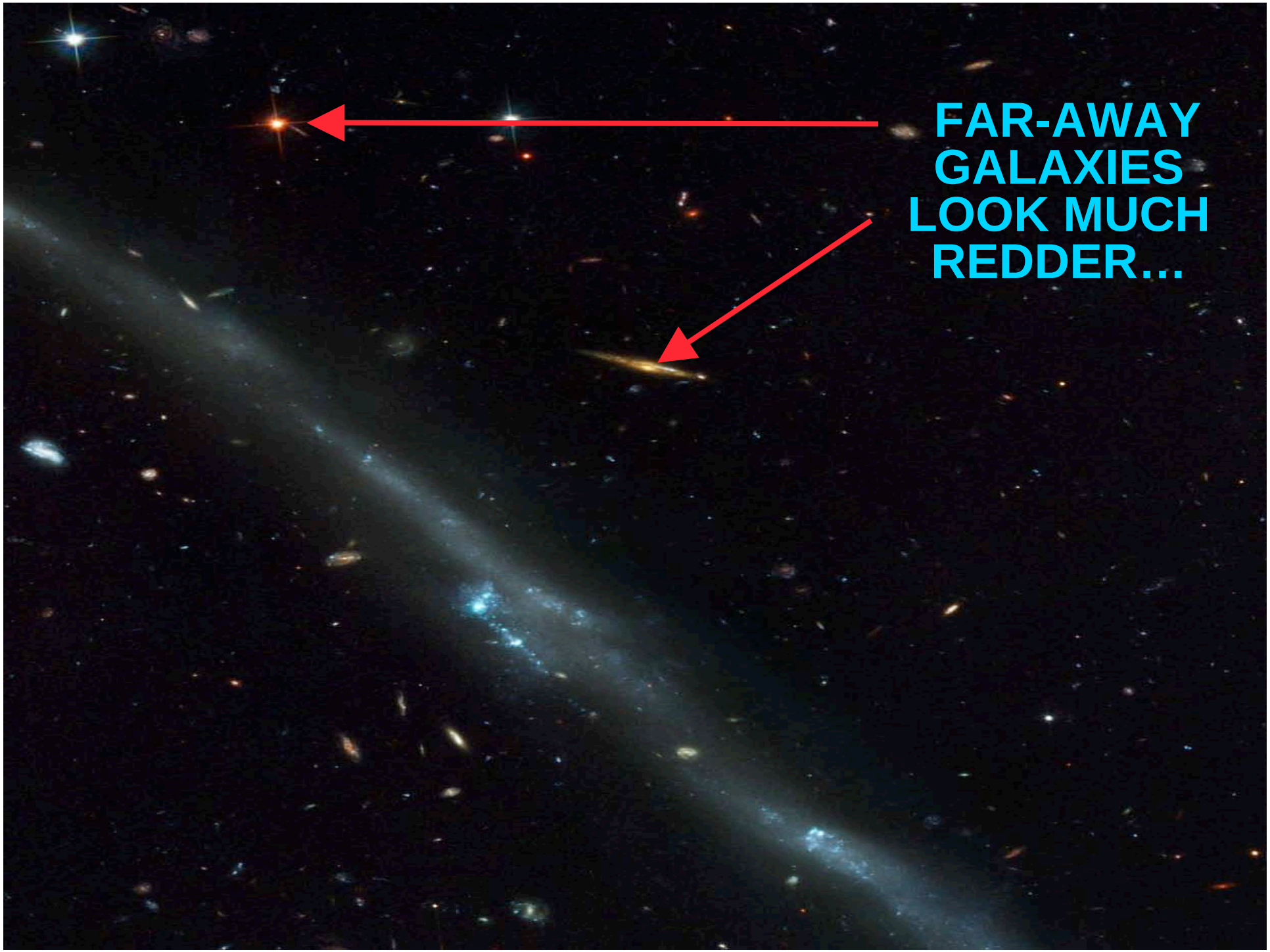
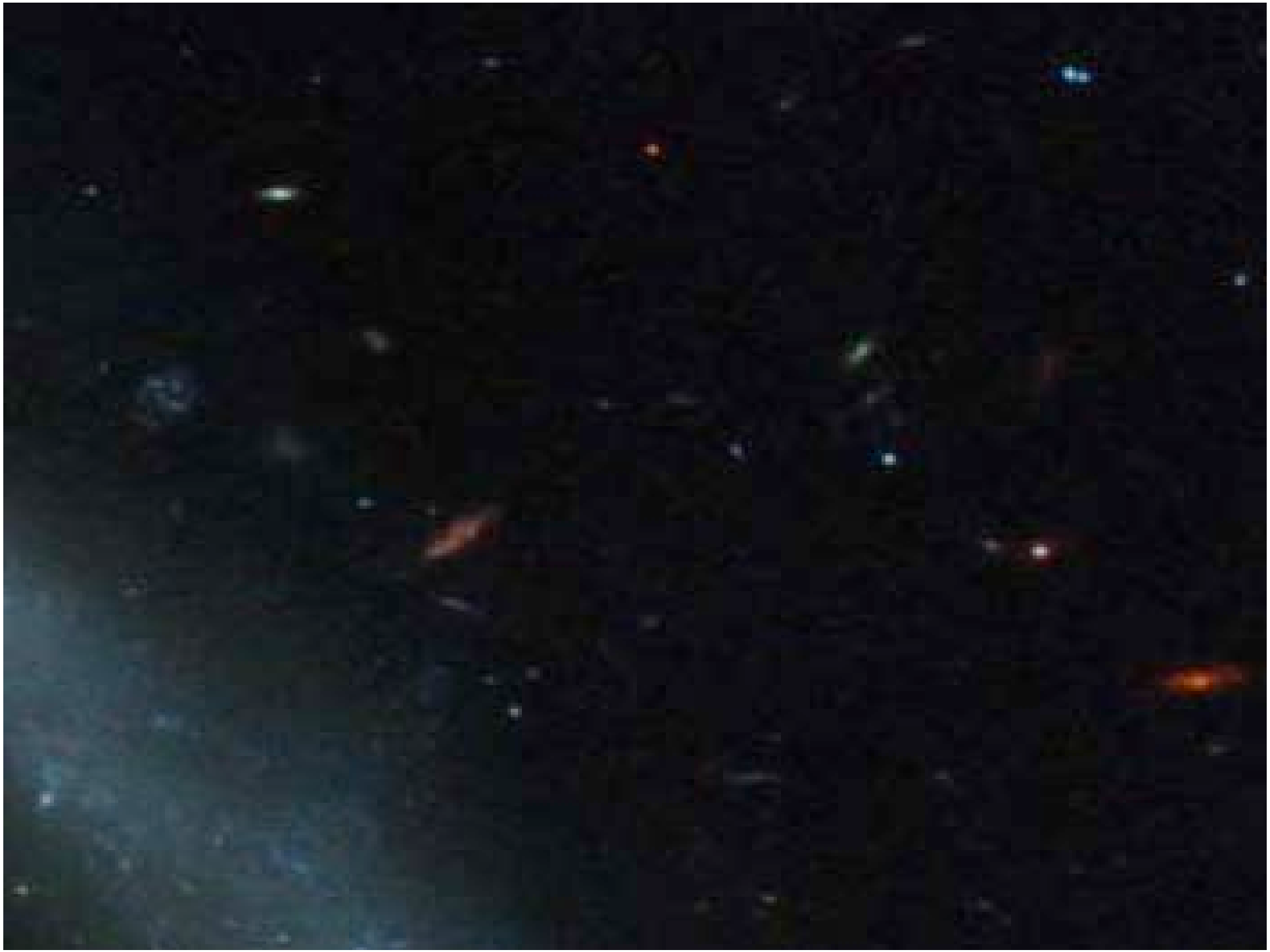
HST image
of the
“TADPOLE”
interacting
galaxy
Quite nearby:
Blue stars


BUT IN THE
BACKGROUND:


FAR-AWAY
GALAXIES
LOOK MUCH
REDDER...




… AND SOME ARE
ALMOST
INVISIBLE

FIR/subMM? (difficult)

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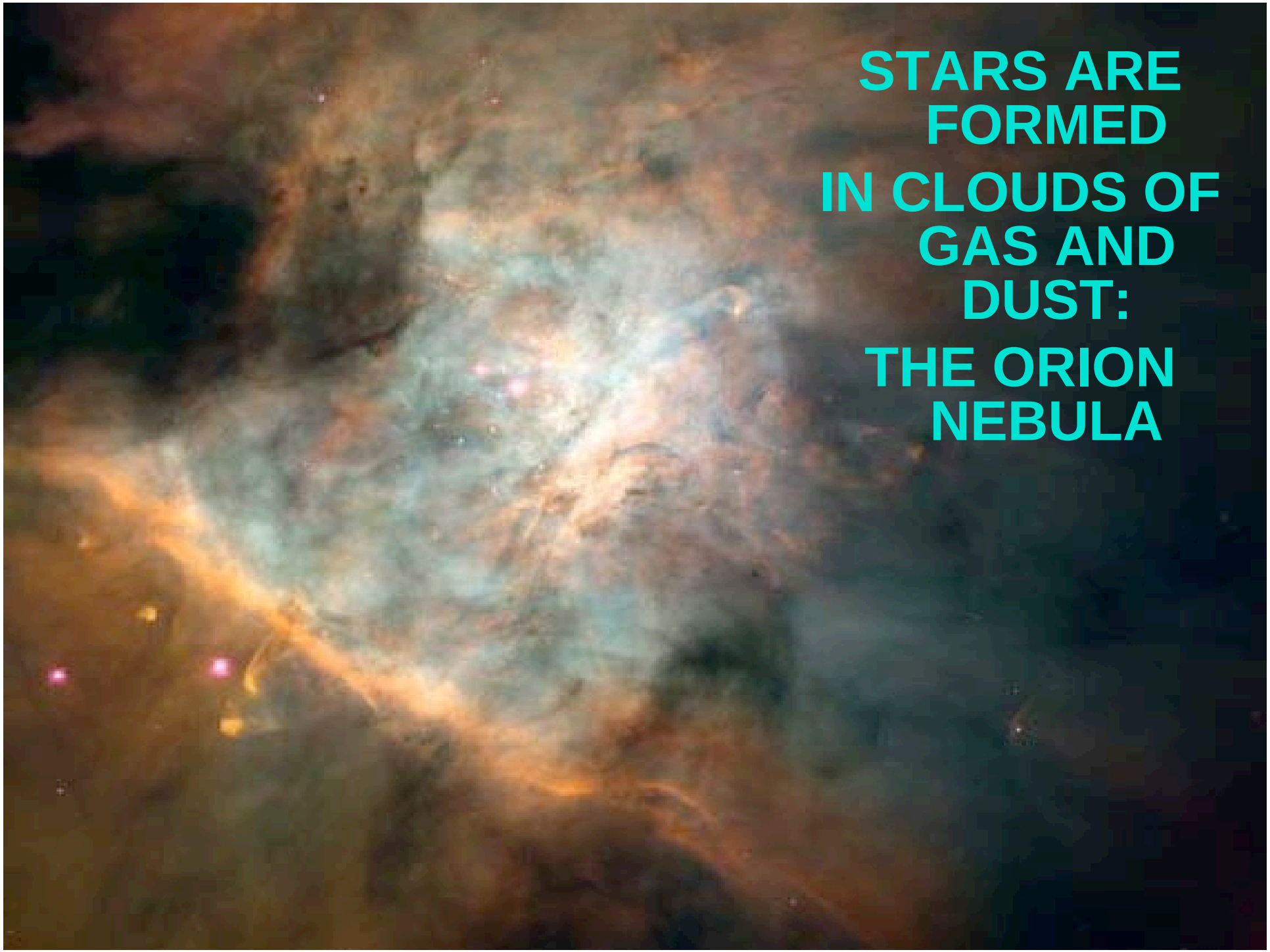
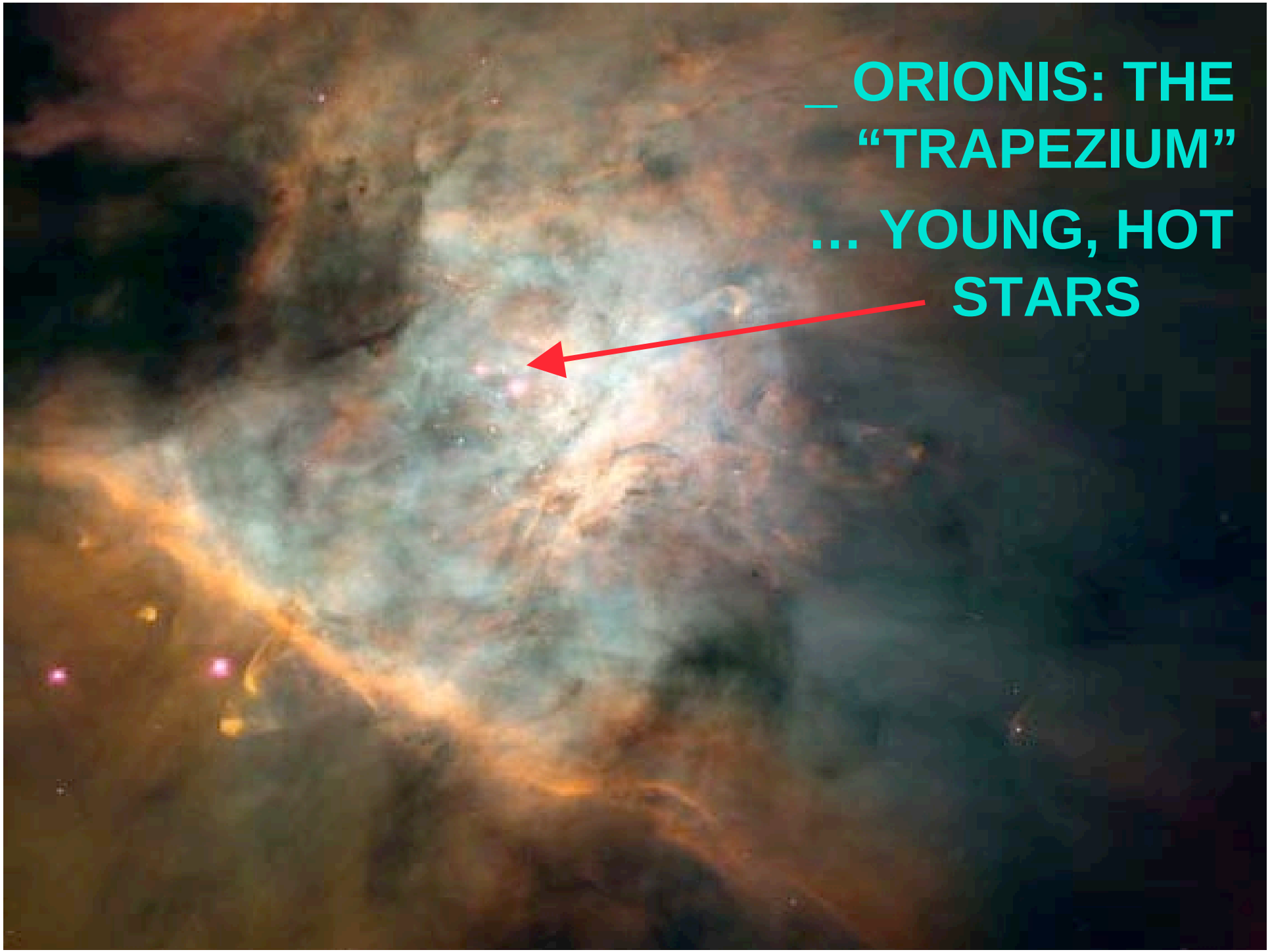
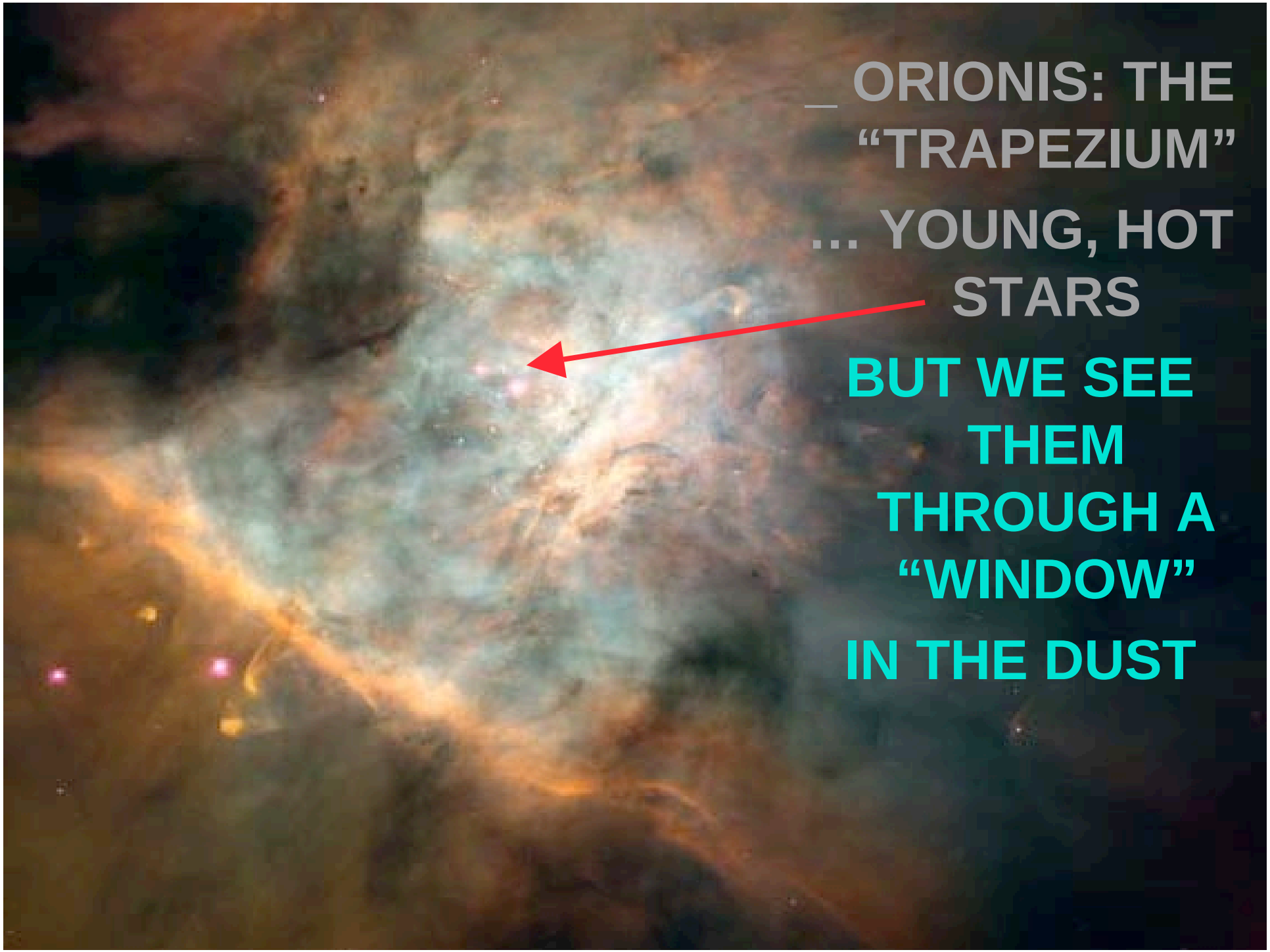
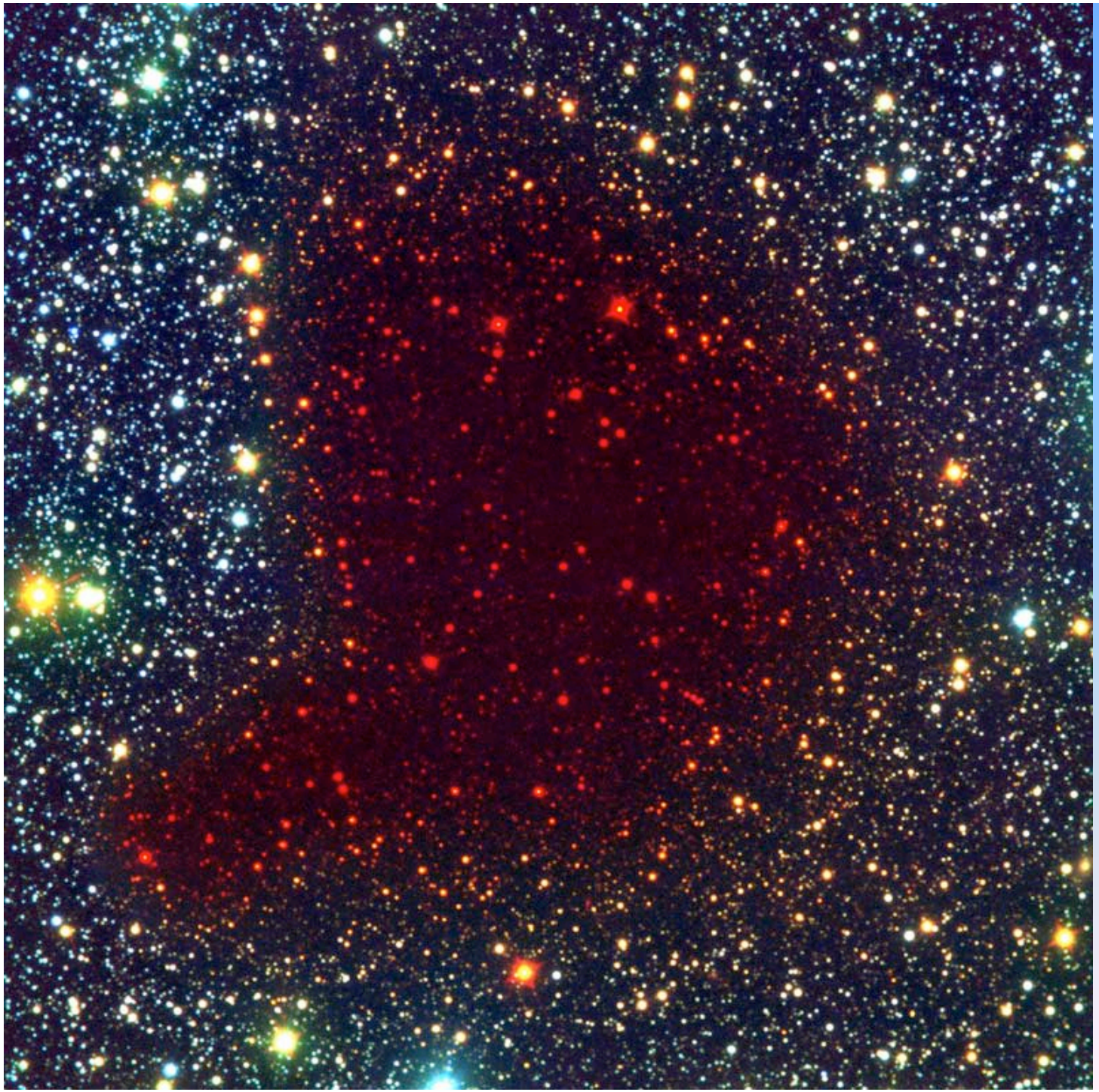

STARS ARE FORMED
IN CLOUDS OF GAS AND DUST:
THE ORION NEBULA


_ ORIONIS: THE
“TRAPEZIUM”
… YOUNG, HOT
STARS


_ ORIONIS: THE "TRAPEZIUM"
... YOUNG, HOT STARS
BUT WE SEE THEM THROUGH A "WINDOW" IN THE DUST


HOW CAN WE SEE
THROUGH DUST
WITHOUT A WINDOW?



.. BY USING INFRARED LIGHT

…this image uses light 2 to 4 times longer in wavelength than that by which we see…

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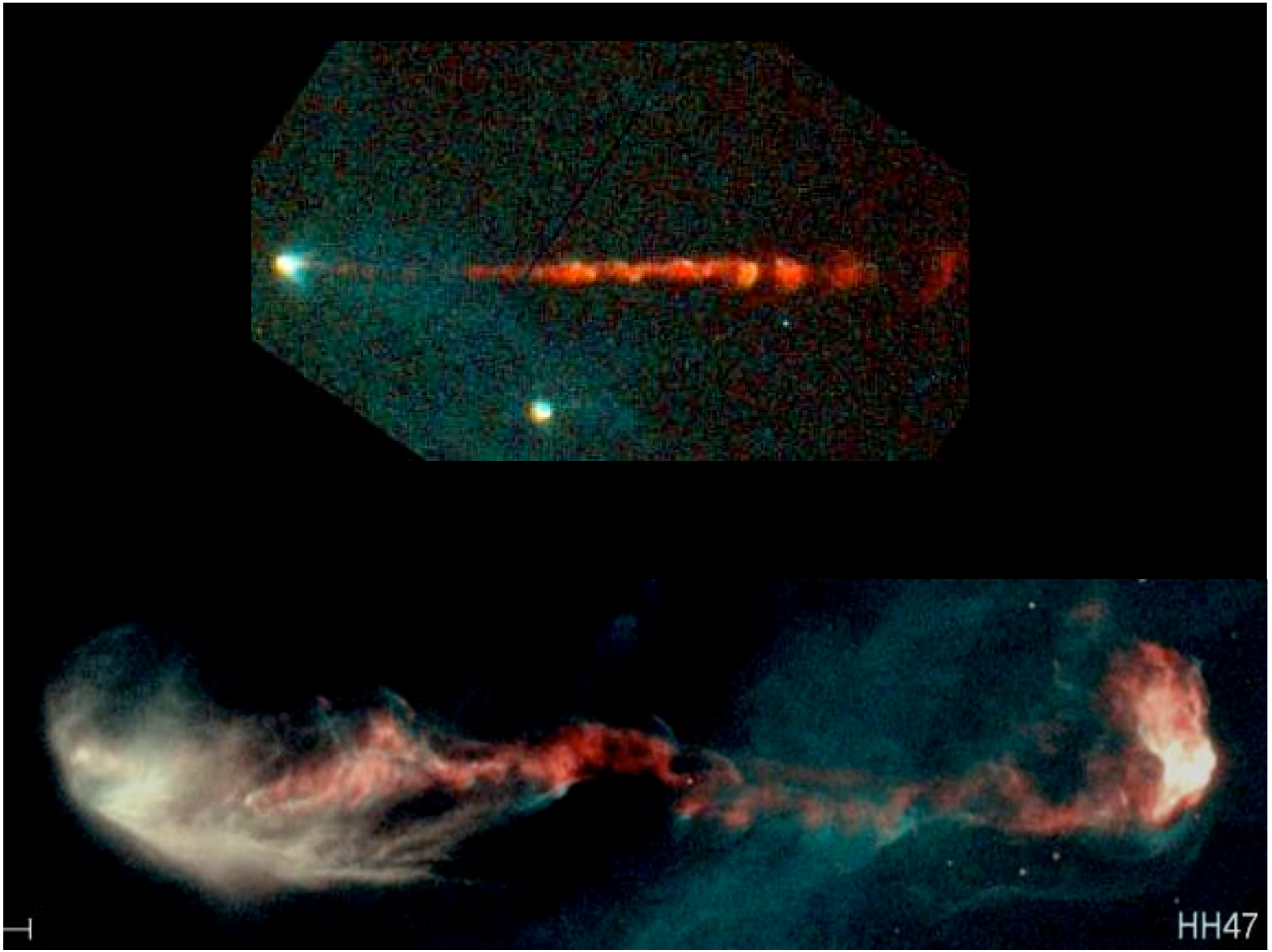
AND THE
INFRARED
CAN SHOW US
EVEN MORE..


WHAT ARE
THESE??

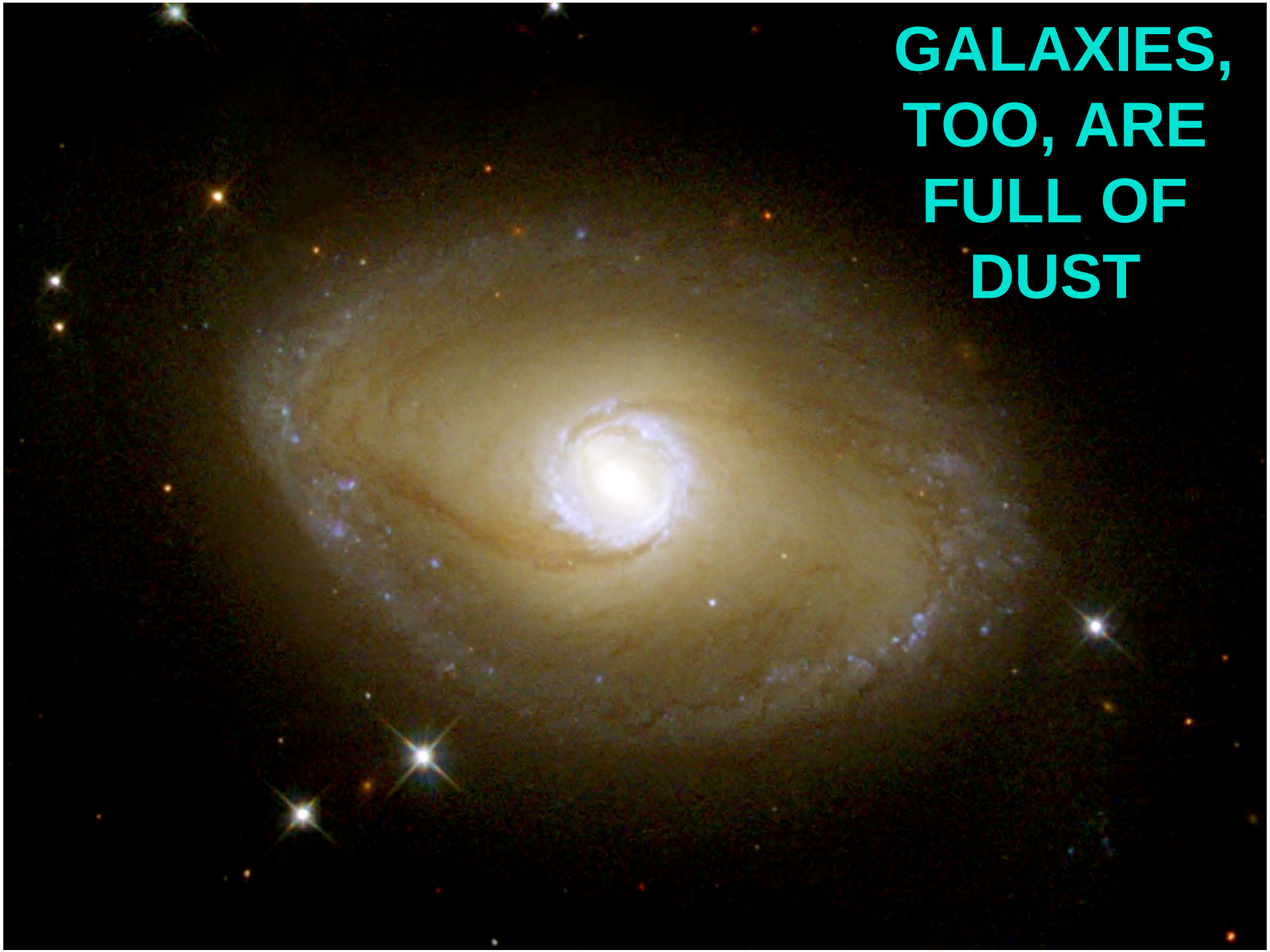

BABY STARS
STILL WRAPPED
IN DUST


YOUNG
STARS DO
MANY
EXCITING
THINGS

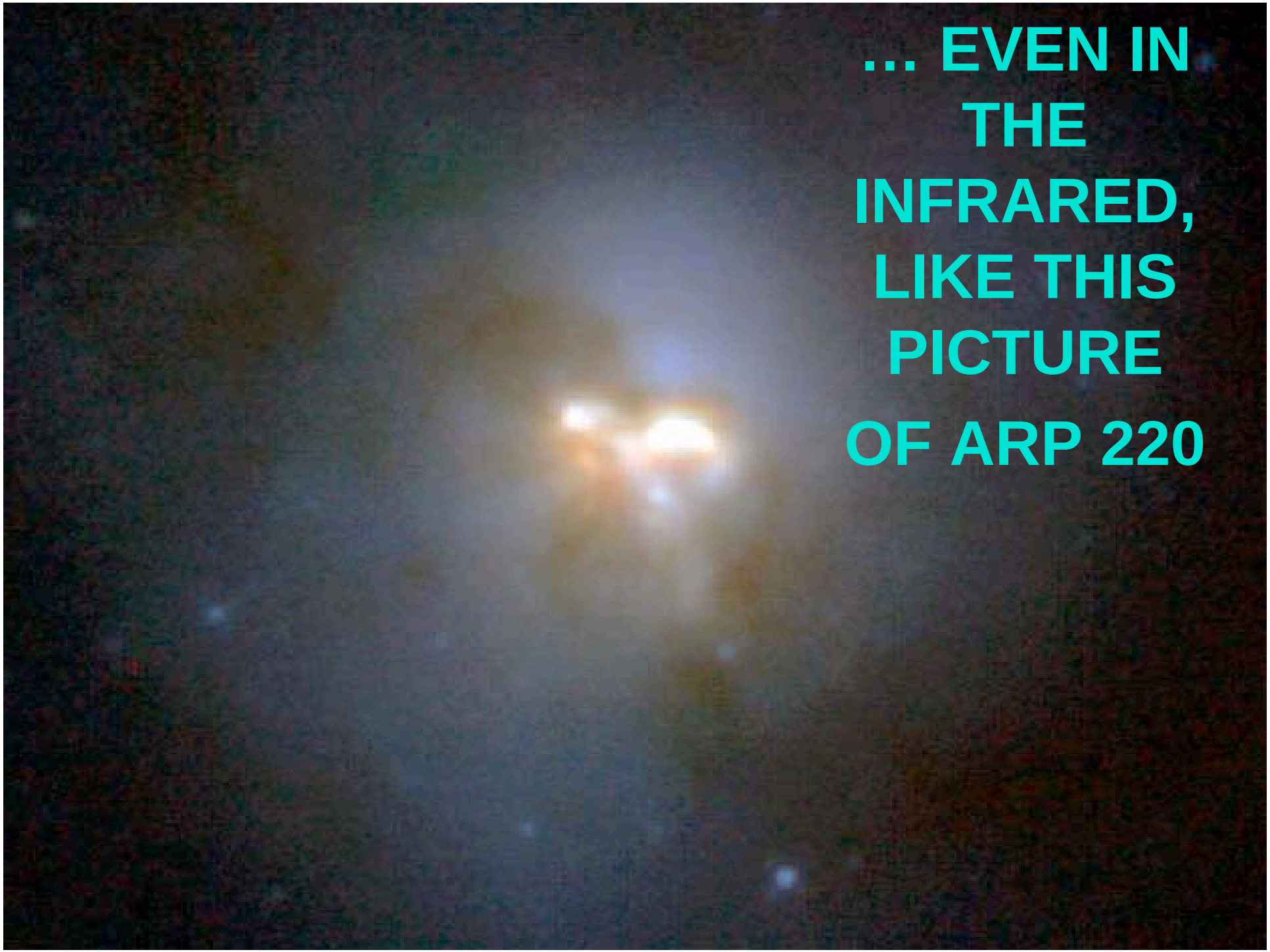

HH47


BUT WE STILL
CANT SEE
THEM
CLEARLY…

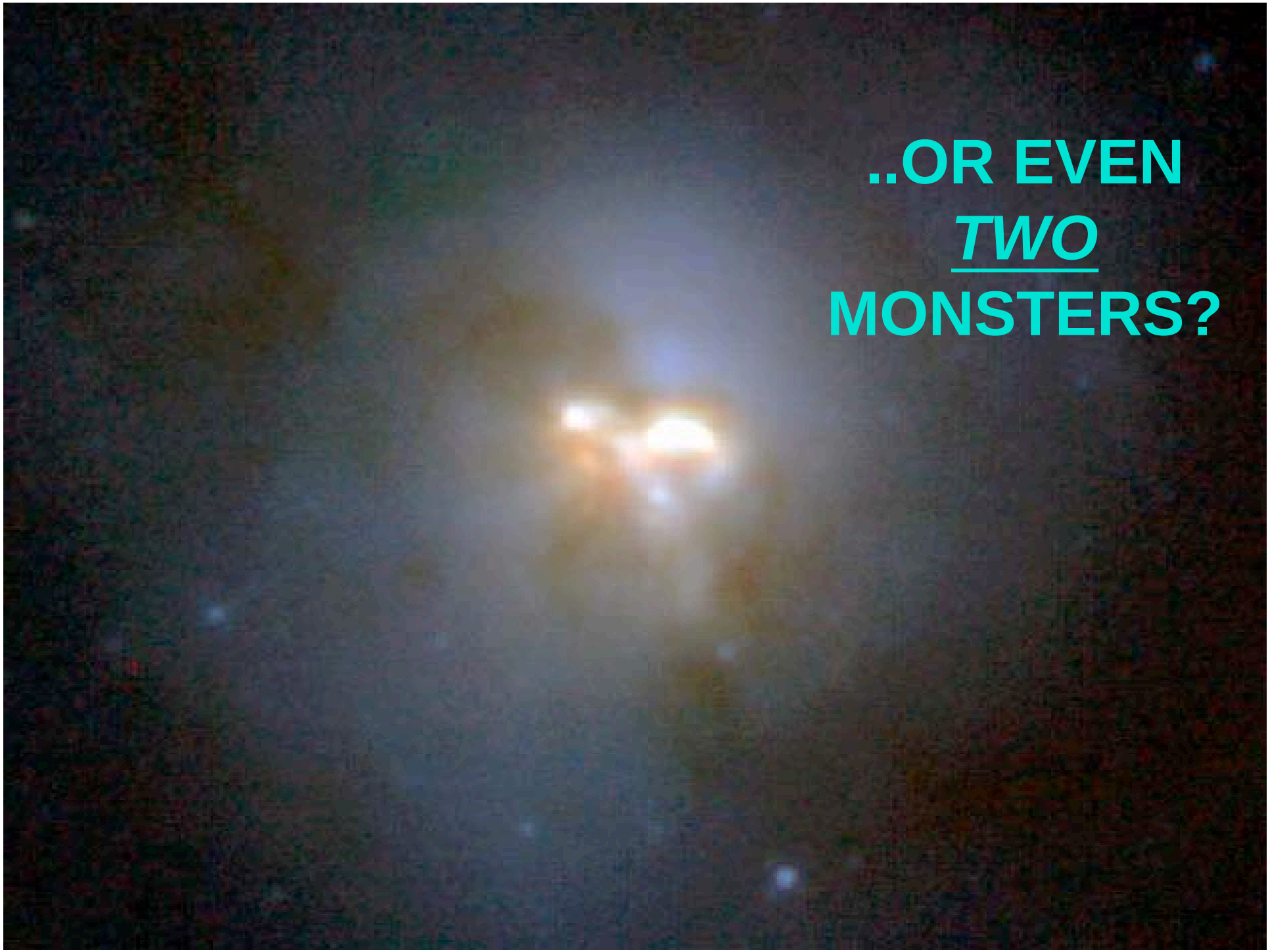

...THE STAR ITSELF IS INVISIBLE, EVEN IN THIS NEAR-INFRARED PICTURE, BEHIND ITS DISC OF DUST


GALAXIES,
TOO, ARE
FULL OF
DUST


AND WE
CAN'T SEE
WHATS
HAPPENING,
ESPECIALLY
IN THEIR
CENTRES…


... EVEN IN
THE
INFRARED,
LIKE THIS
PICTURE
OF ARP 220


... DOES IT
CONTAIN A
MONSTER
BLACK HOLE?


..OR EVEN
TWO
MONSTERS?

….WE NEED THE FAR INFRARED AND SUBMILLIMETRE TO SEE WHATS GOING ON

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- **GIANT? (expensive)**
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GIANT? (expensive)

The longer the wavelength,

the more blurred the image ….


SOMETHING
WHICH LOOKS
LIKE THIS IN
VISIBLE
LIGHT
(_ =0.5µm)…


MIGHT LOOK LIKE
THIS IN THE FAR
INFRARED
(_ = 100μm)…

SPACE?

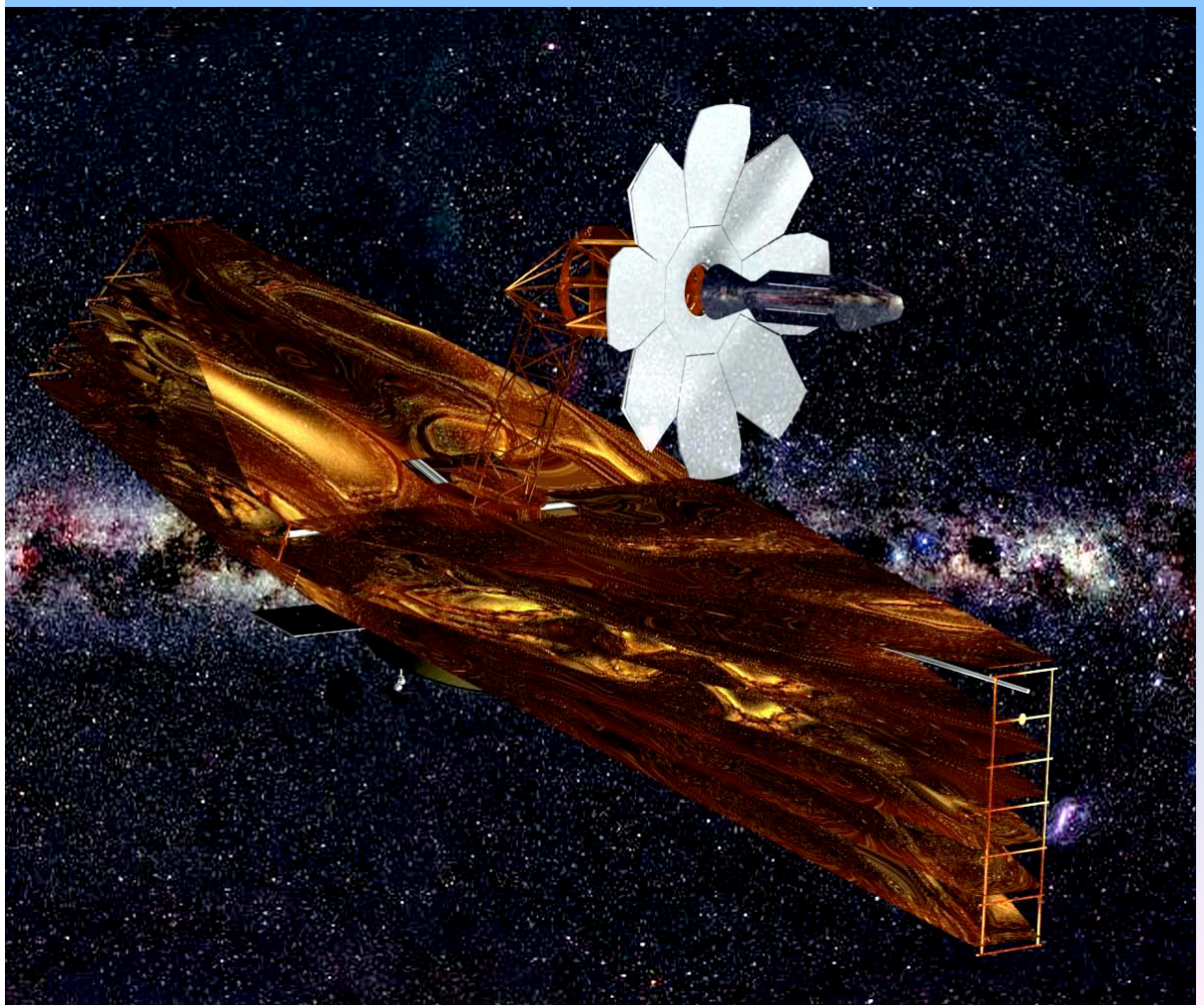
(expensive and difficult)

Unfortunately, no far-IR and very little sub-millimetre light can get through the atmosphere…

NASA PROPOSAL: SAFIR

(10M, 4K telescope)

… in various possible “flavours”



a bigger, colder JWST with more sunshade layers???

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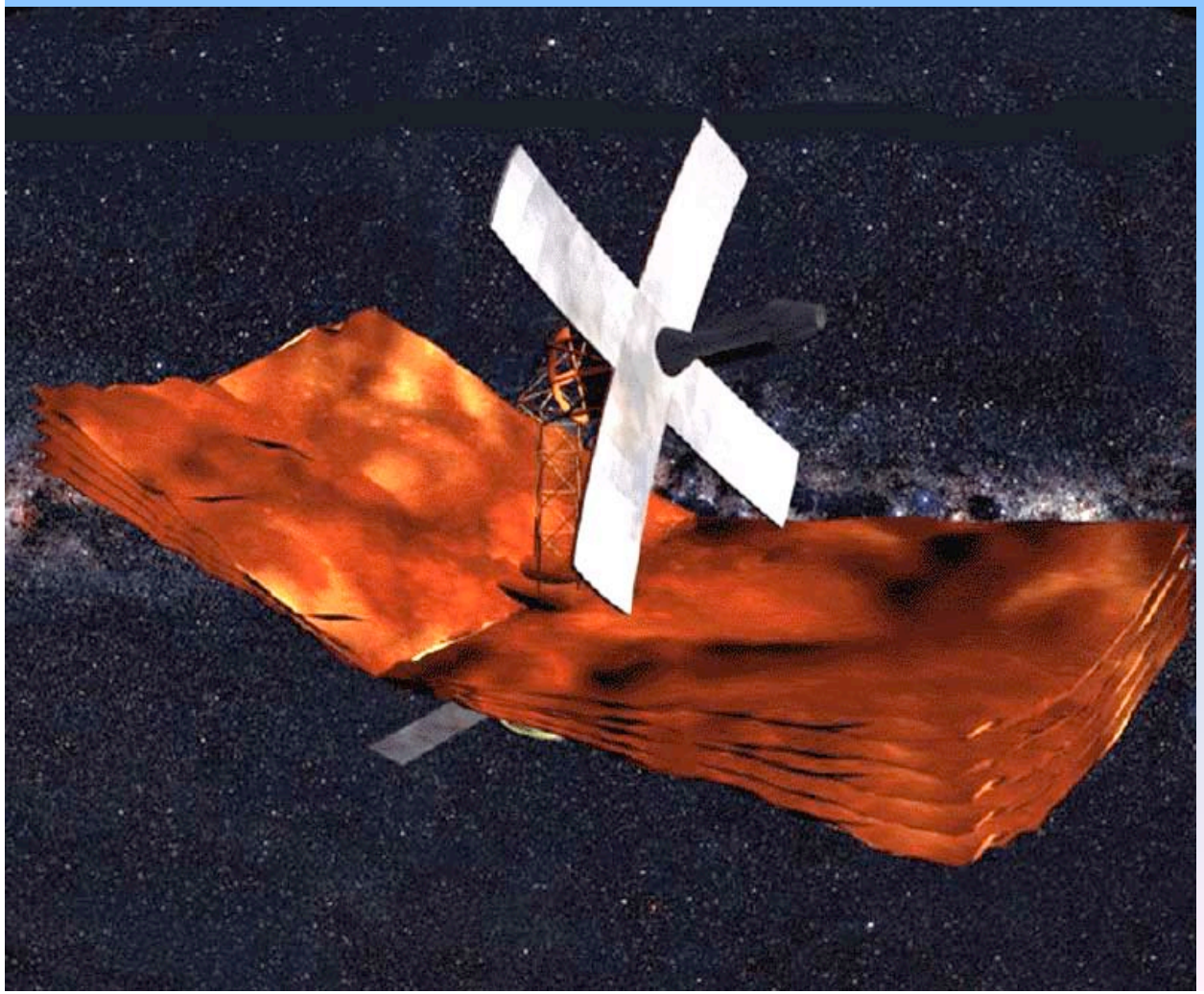
NASA PROPOSAL: SAFIR

(10M, 4K telescope)



a different shape of telescope?

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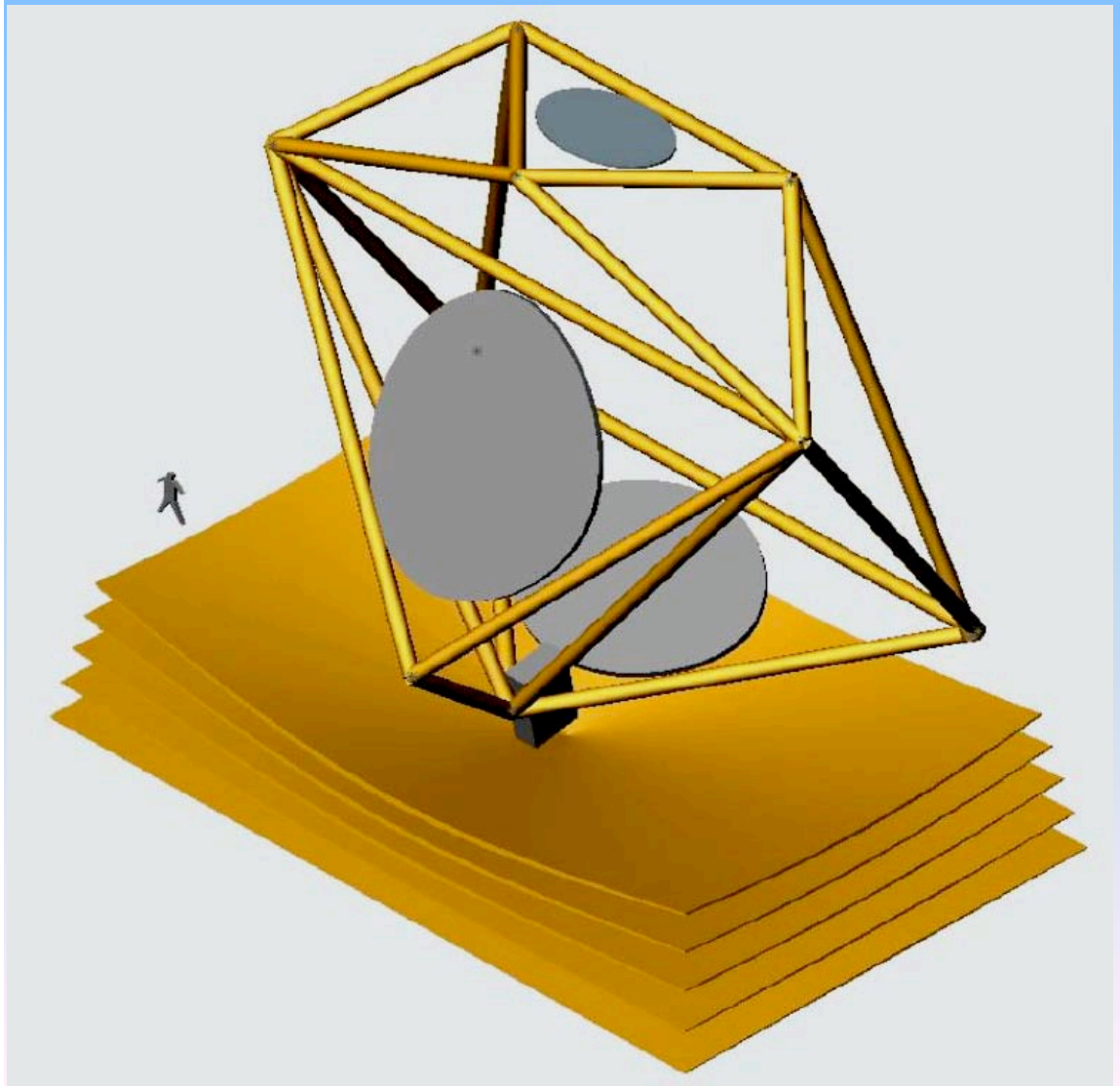
NASA PROPOSAL: SAFIR

(10M, 4K telescope)



a totally new technology? “DART” uses membranes

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ORIGIN OF THIS PROPOSAL:

Invited review of technologies for lightweight, cold, FIR telescopes in space

(for ESA workshop, *"New Perspectives for Post-Herschel FIR Astronomy from Space"* Madrid, 1-5 Sept 2003)

PERSONAL GOAL OF REVIEW:

An outline design for a telescope that is:

- **Large (>>10m)**
- **Cold (<<30K)**
- **To work in the FIR-submm (~20 to ~700_m),**

….. and has a chance of flying in my lifetime…

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RESULTS

- ***Membranes*** **have plenty of problems (cusps, wrinkles, uniformity, how to tension, shape control…)**
- ***"Stiff" technologies*** **unlikely to offer >>10m aperture***

↑ ***Fresnel lenses*** **being explored at LLNL for optical applications**

→ ***must be 50-1000x easier in FIR-submm!***

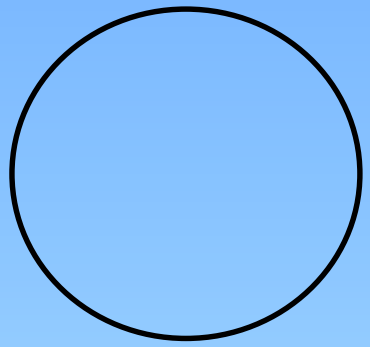
(inspiration: J. Early et al, proc SPIE, 5166, 148)

***But see TRW plans for 30m JWST-style telescope for 7-17_m:**

C.F. Lillie et al., Proc SPIE, 4860, 84 (2003)

Fresnel Lenses

Ordinary lens



Cross-section: Thick centre