



Pengamatan Virtual Langit Malam

Berkenalan dengan Materi AntarBintang



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**RUANG ANTAR BINTANG
TIDAK KOSONG**

MATERI ANTARBINTANG (MAB)

atau *interstellar matter* (ISM) merupakan **materi yang mengisi ruang di antara bintang**.

- Gas dan Debu



Awan antarbintang (*interstellar cloud*)
Nebula

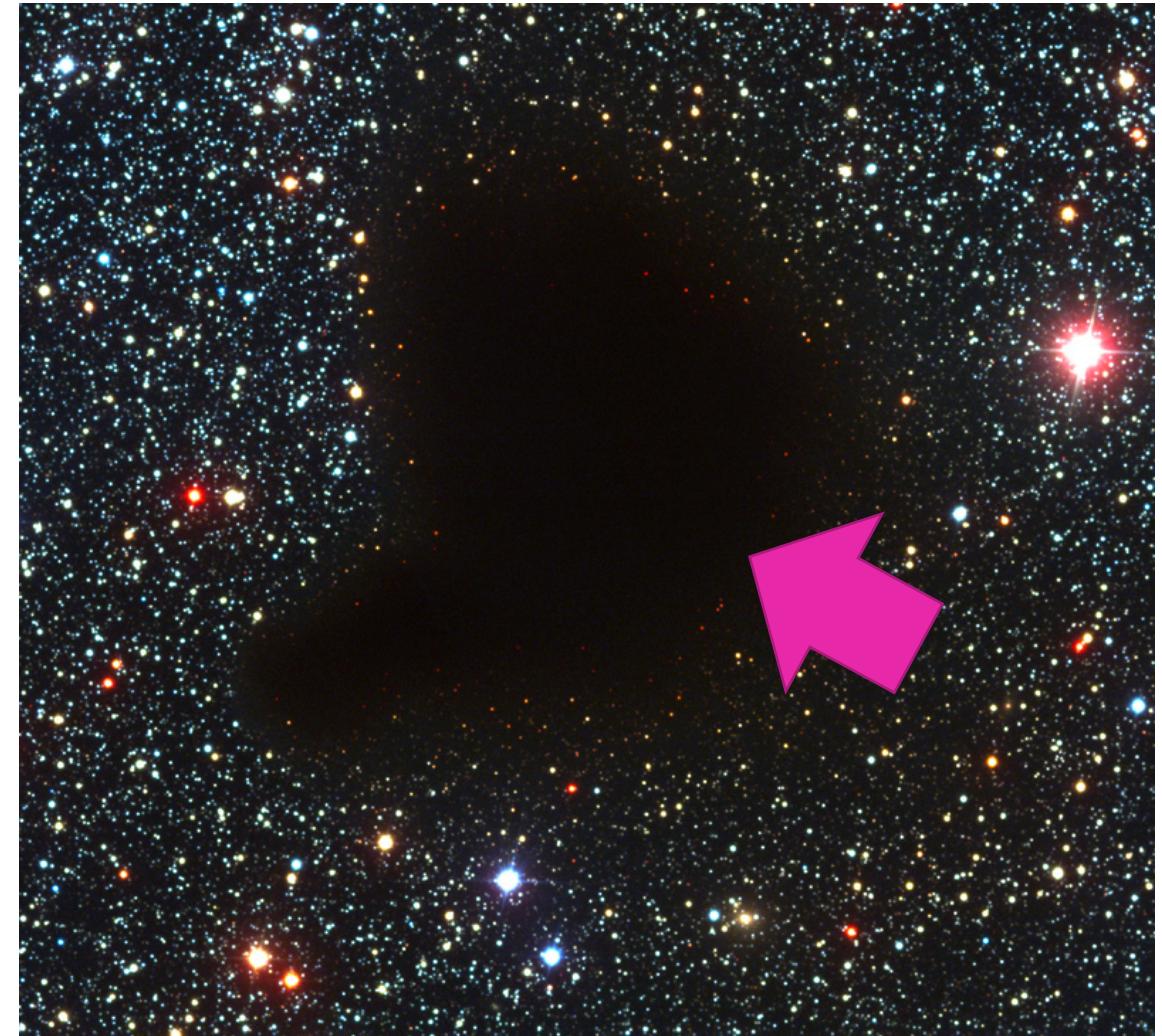


Sumber Gambar: NASA, ESA, Hubble Heritage Team

PENEMUAN MAB

Astronom mengetahui adanya area gelap (tanpa bintang)

- Apakah area gelap ini “lubang”?
- Ataukah ada materi yang menutupi bintang-bintang?



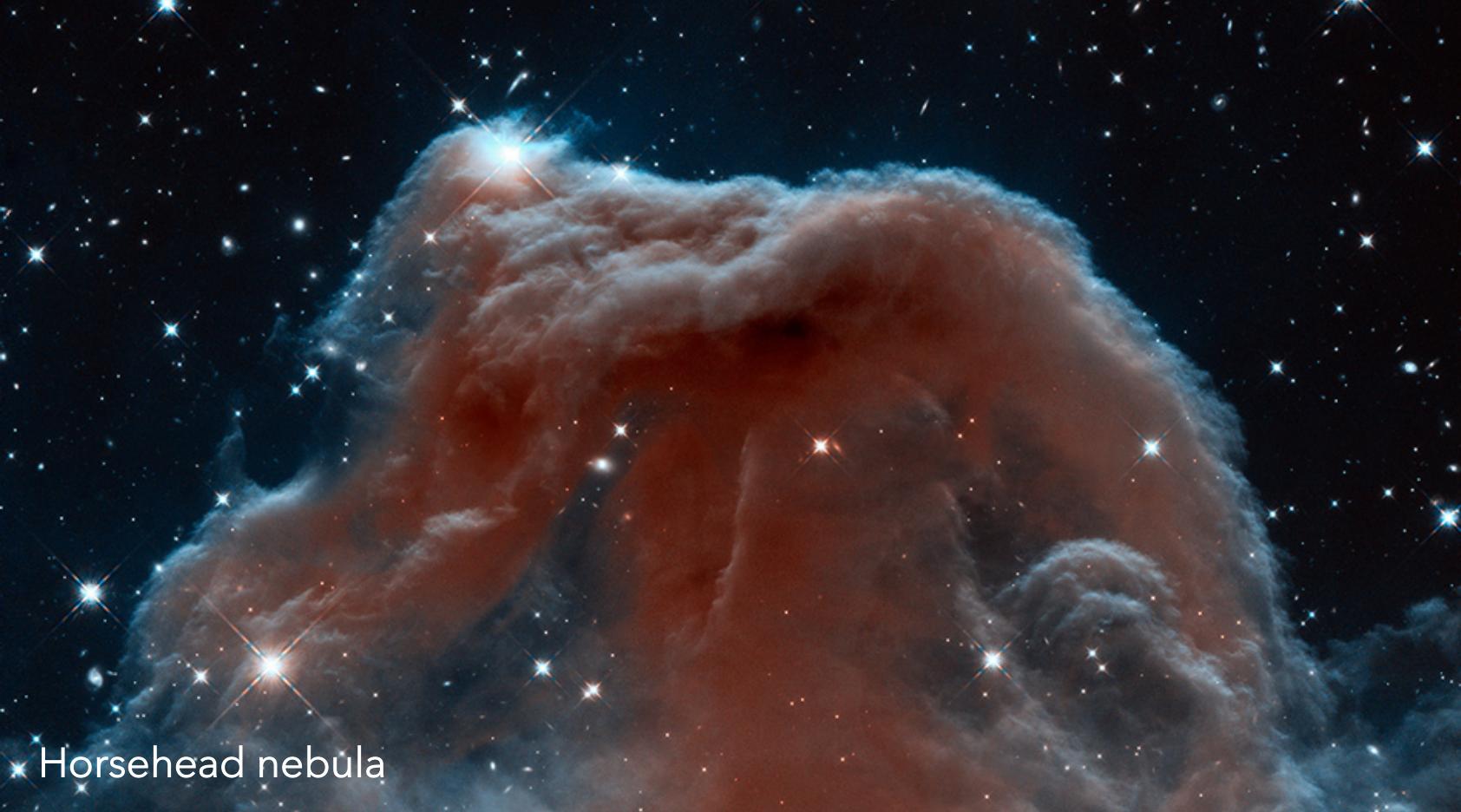
ESO PR Photo 20a/99 (30 April 1999)

The "Black Cloud" B68
(VLT ANTU + FORS1)

© European Southern Observatory



Sumber Gambar: ESO



Horsehead nebula



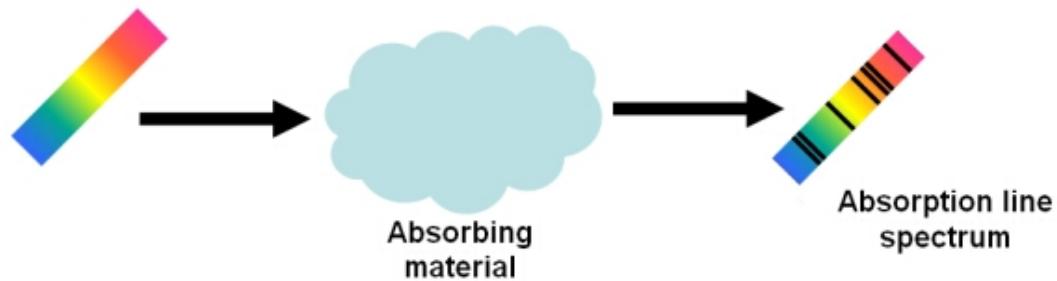
Galaksi Andromeda

Sumber Gambar: NASA, ESA, Hubble Heritage Team

Astronom mengamati objek “*diffused*” yang disebut nebula

BUKTI HISTORIS MAB

- Fotografi awan gelap (*dark cloud*) maupun *diffused astronomical object*
- Studi statistik ukuran dan kecerlangan gugus bintang (Trumpler 1930)
- Cacah bintang (*star count*)
- Garis serapan pada spektrum (Johannes Hartmann 1904)



Sumber Gambar: Isaac Newton Group of Telescopes



The "Black Cloud" B68
(VLT ANTU + FORS1)

Sumber Gambar: ESO

BAGAIMANA MENDETEKSI MAB?

Gambar (image)



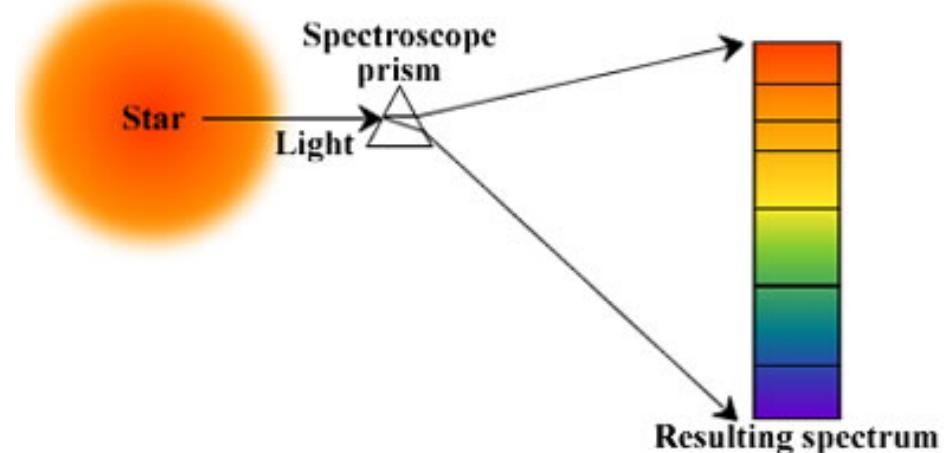
Sumber Gambar: ESO

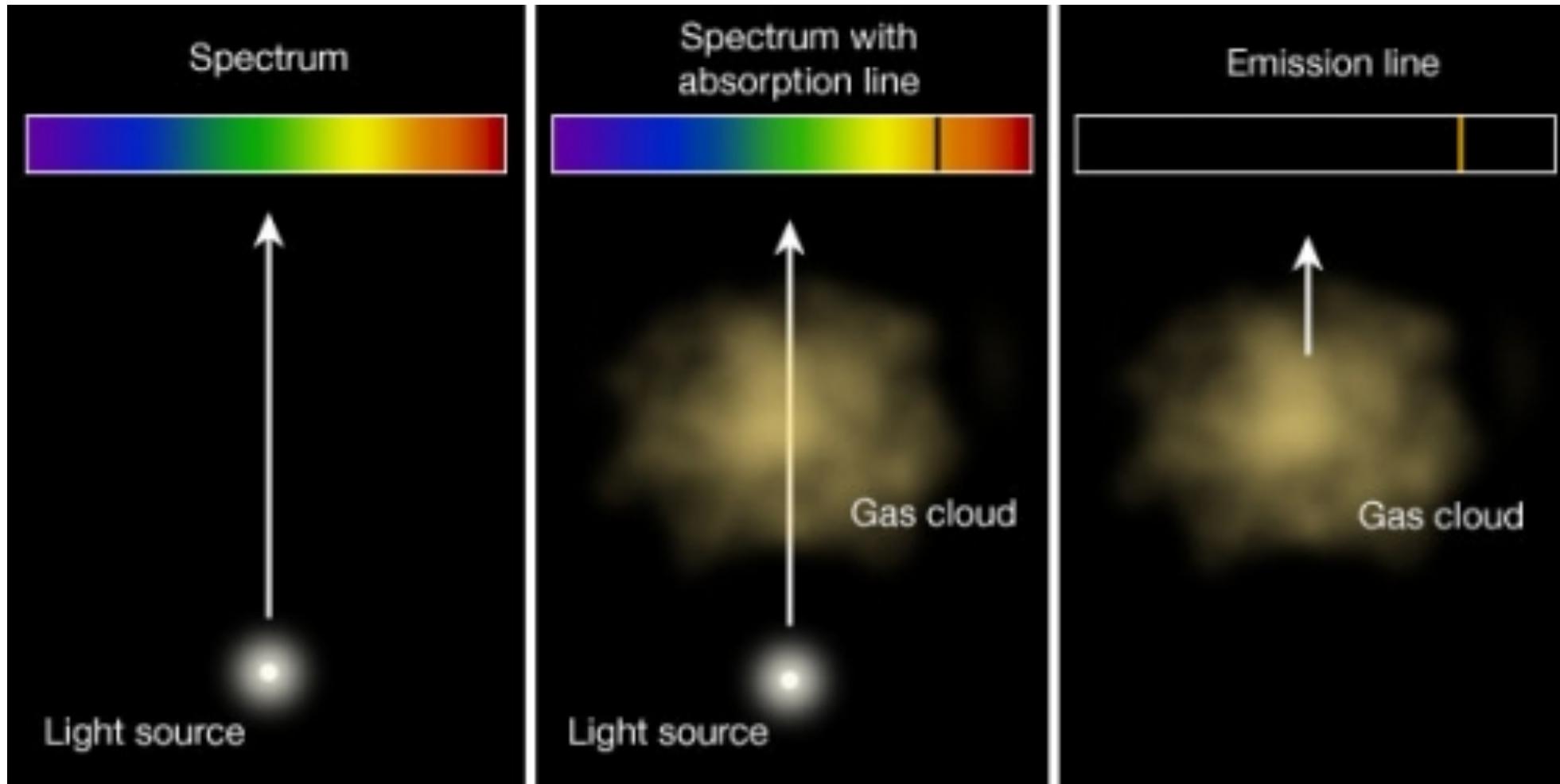


Sumber Gambar: NASA, ESA, Hubble Heritage Team

Spektrum

- Distribusi energi terhadap panjang gelombang

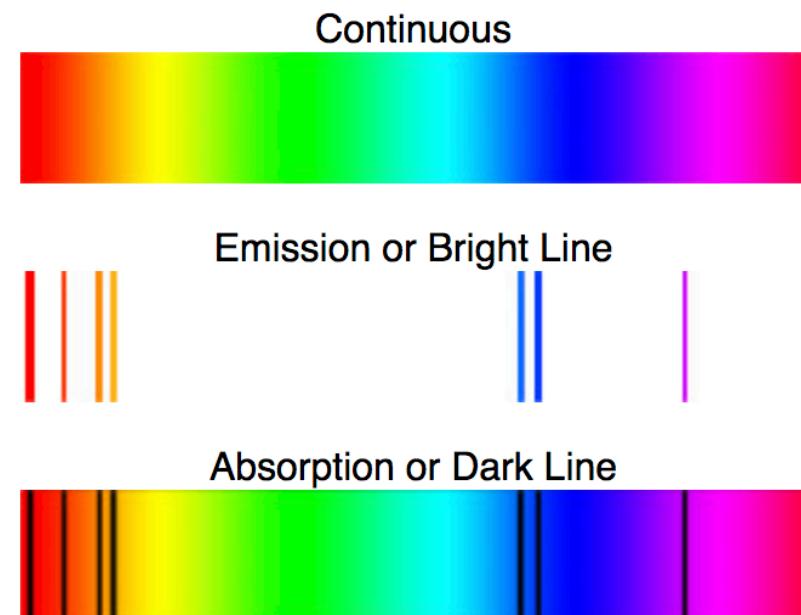




Sumber Gambar: *Penn State Astronomy & Astrophysics*

INFORMASI YANG DIPEROLEH DARI SPEKTRUM

- Spesies (atom/molekul)
- Kelimpahan atom/molekul
- Gerak/kinematika
- Tekanan, temperatur, medan magnet dll.



Three types of spectra: continuous, emission line and absorption.(Credit: NASA's Imagine the Universe)

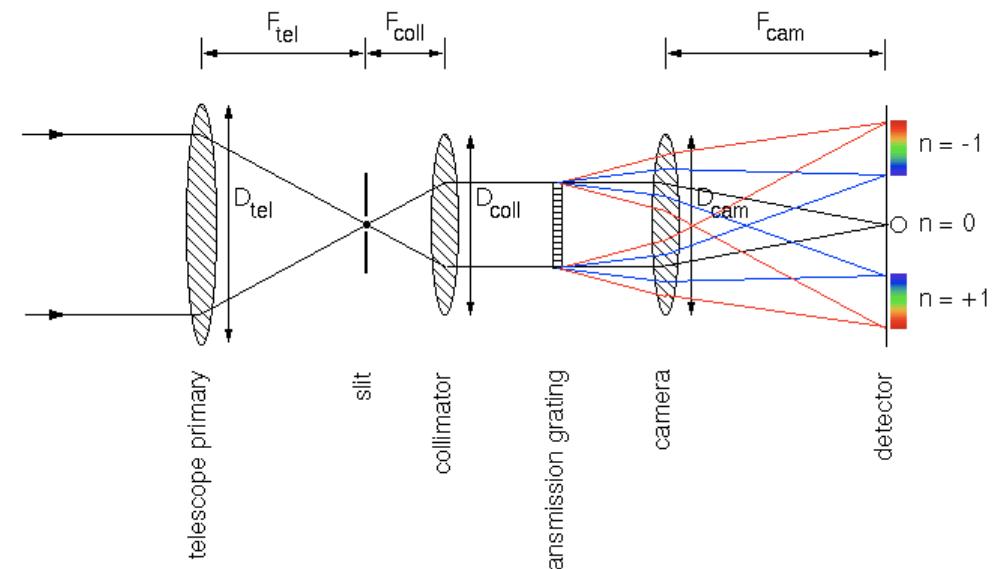
SPEKTROGRAF



Spektrograf NEO R1000
Kerjasama ITB dan Kyoto-
Sangyo University.



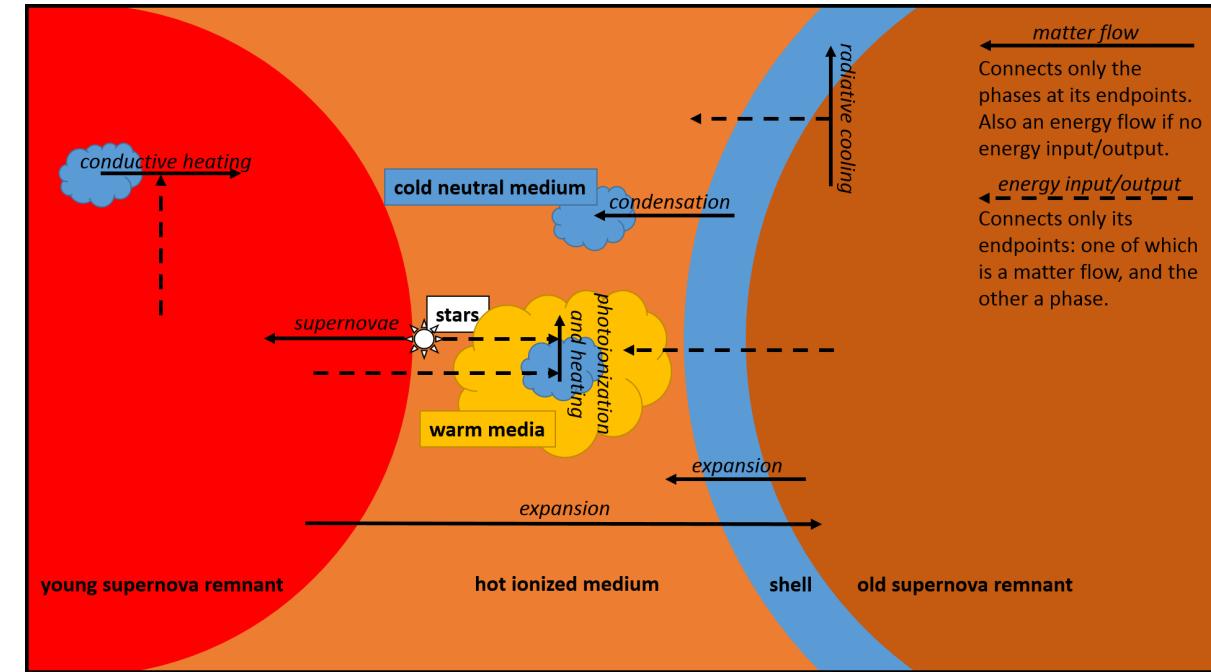
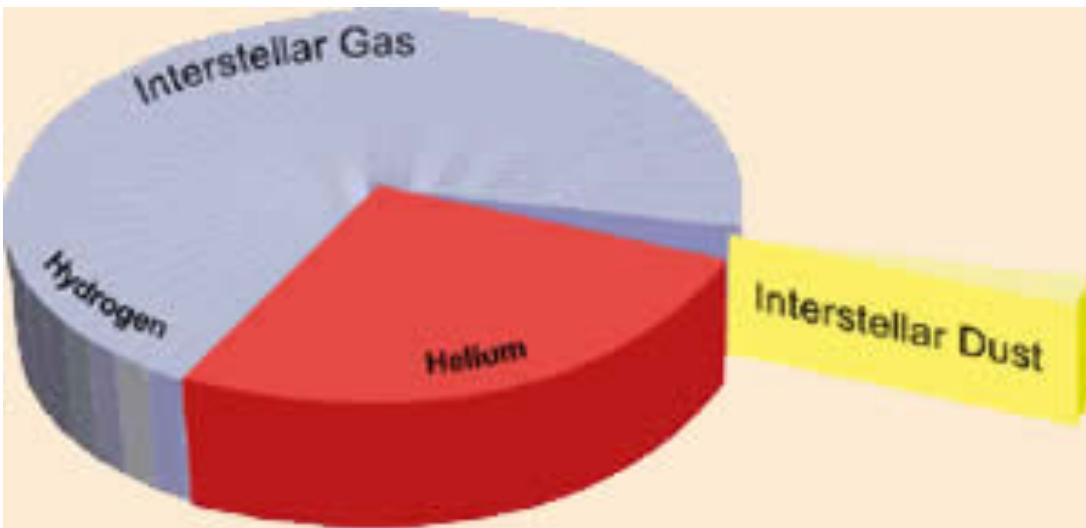
Spektrograf LHIRES III



Sumber Gambar: *Vik Dhillon*

KOMPOSISI

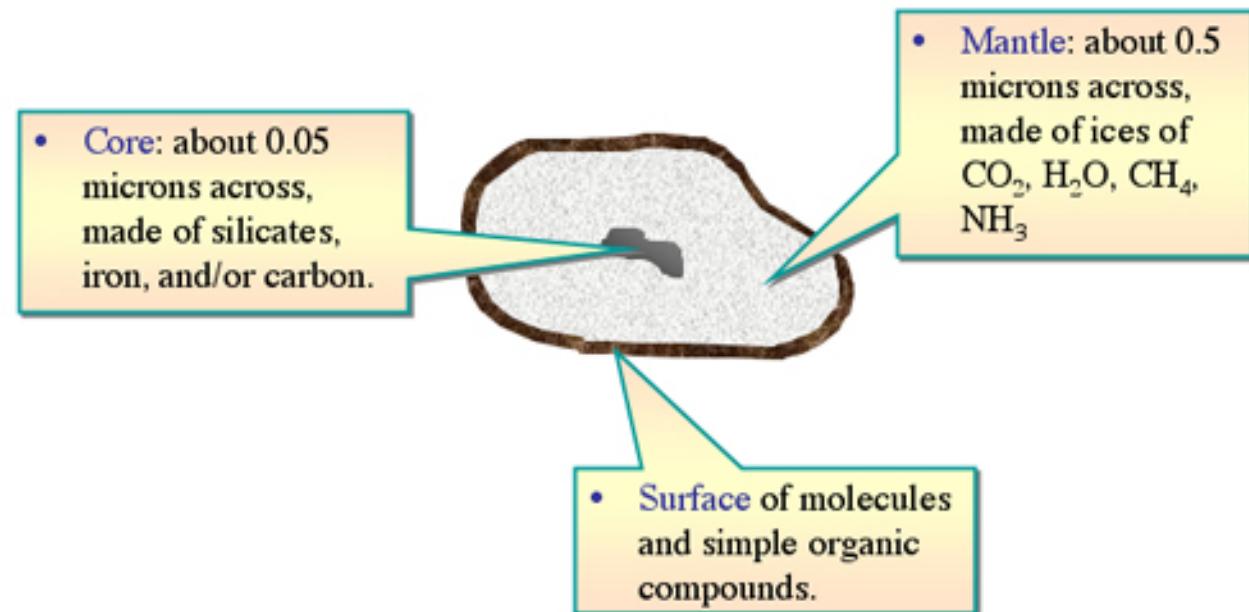
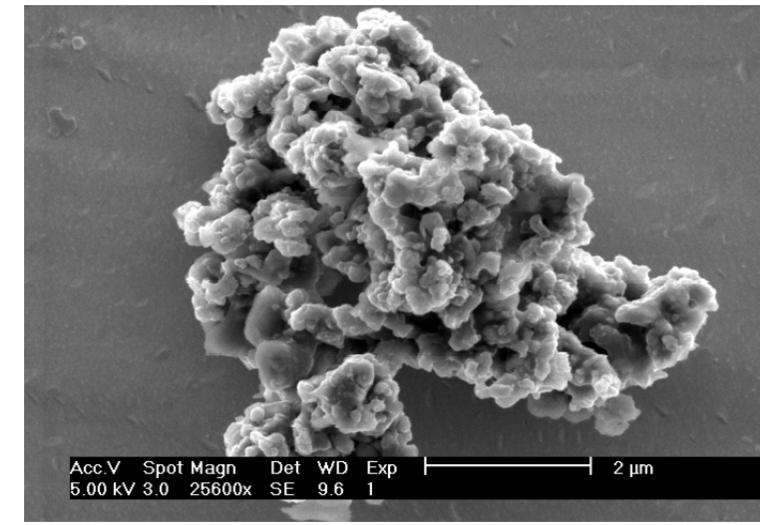
- Gas antarbintang (99%)
- Debu antarbintang (1%)



MAB juga terdapat dalam berbagai fase:
dingin, netral, hangat, dan panas

DEBU ANTARBINTANG

- Karbon / Silikat
- Ukuran orde mikron
- 1% dari massa total MAB di Galaksi
 - Efek signifikan dalam pengamatan astronomi



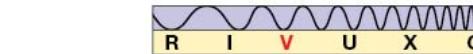
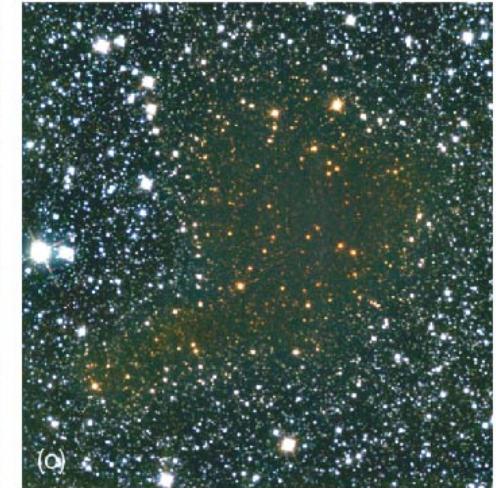
Sumber Gambar: <https://astronomy.swin.edu.au/>

EFEK DEBU ANTARBINTANG

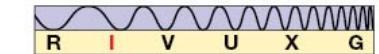
Debu antarbintang menyebabkan objek yang ditutupinya mengalami:

- Peredupan (*extinction*)
- Pemerahan (*reddening*)

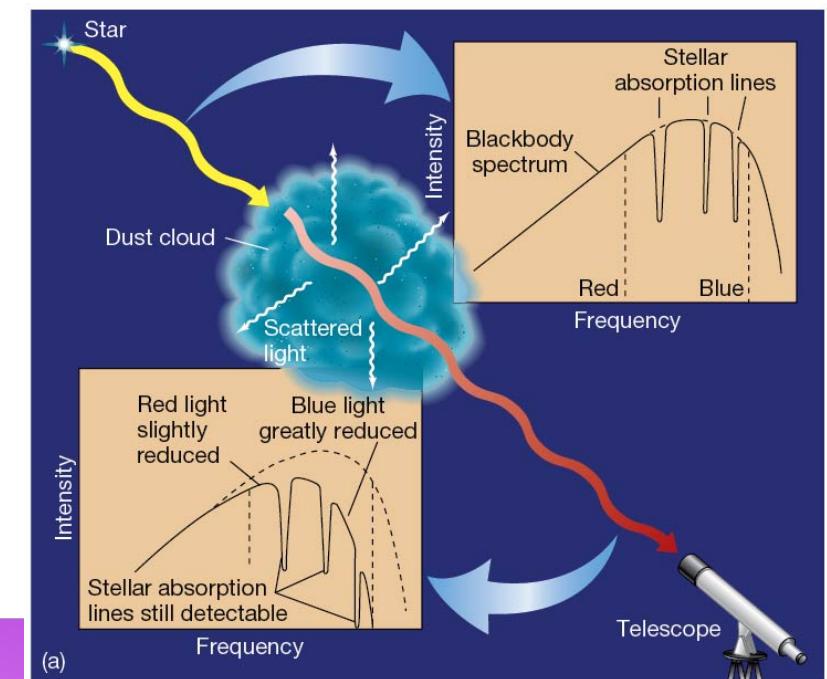
MAB dapat mengubah properti objek langit yang kita amati sehingga penting sekali mempelajarinya.



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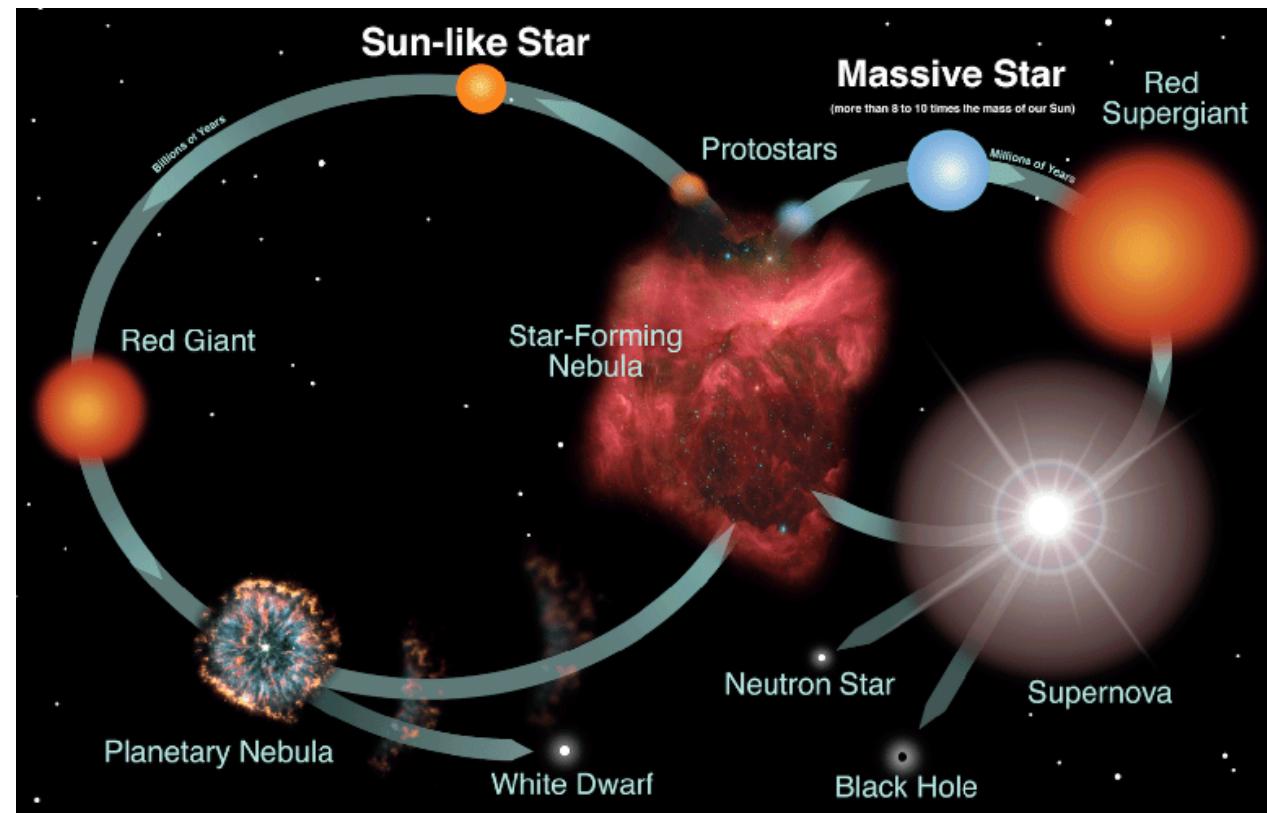


Sumber Gambar: Pearson

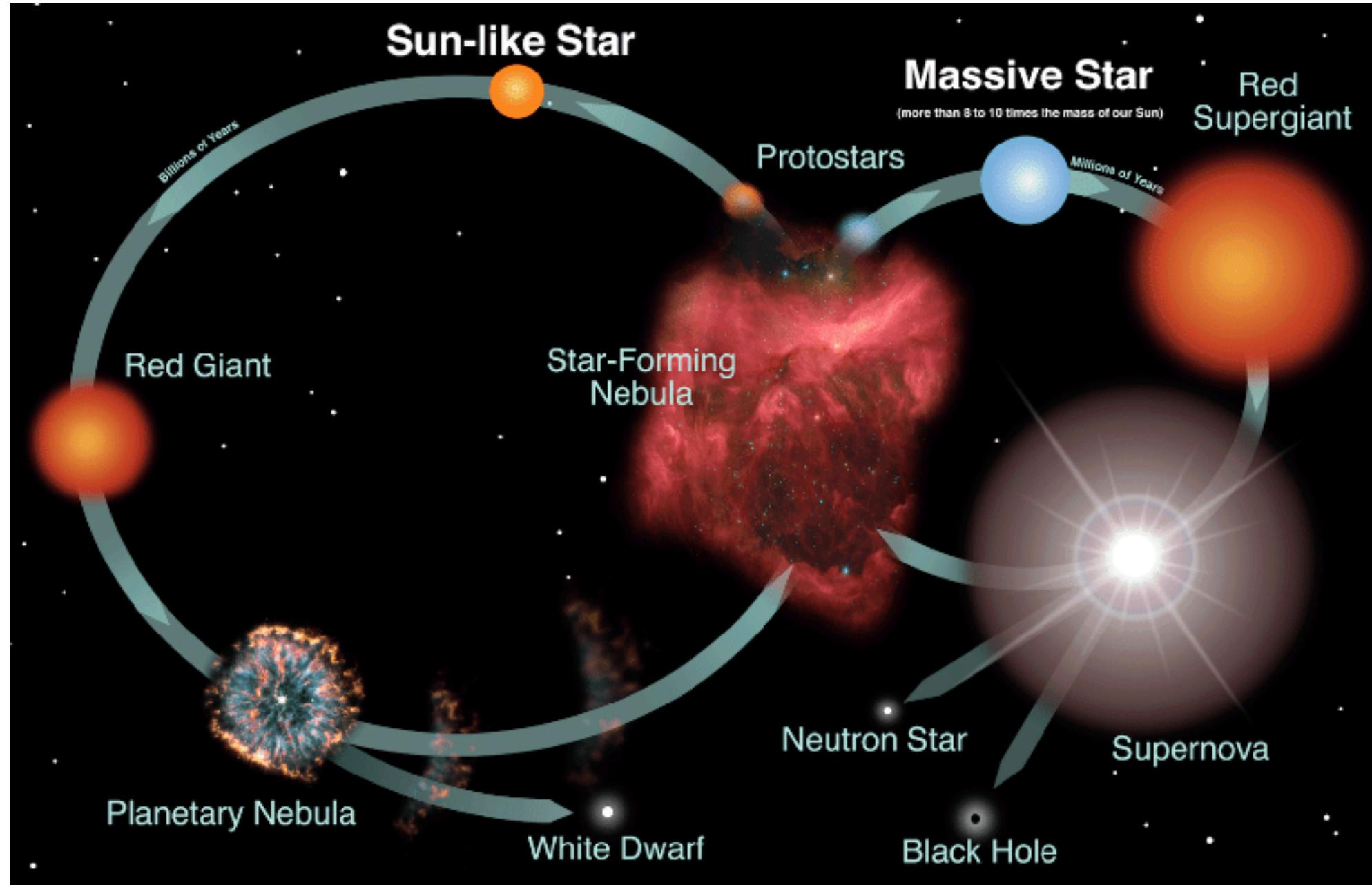


DARI MANA ASAL DEBU ANTARBINTANG ?

- Debu berasal dari lontaran material dari bintang
- Debu terbentuk di daerah dingin dan berkerapatan cukup tinggi → atmosfer bintang raksasa merah

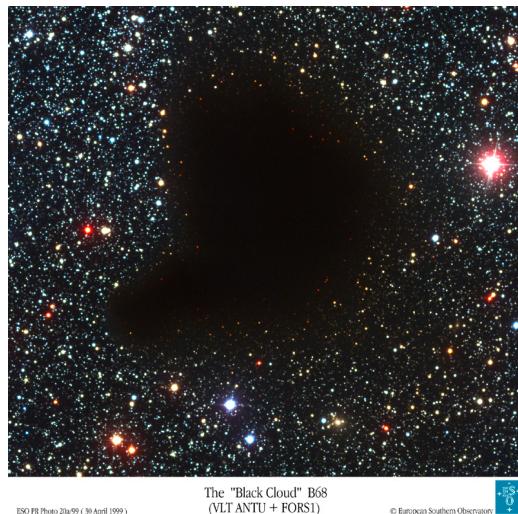


Sumber Gambar: NASA/JPL

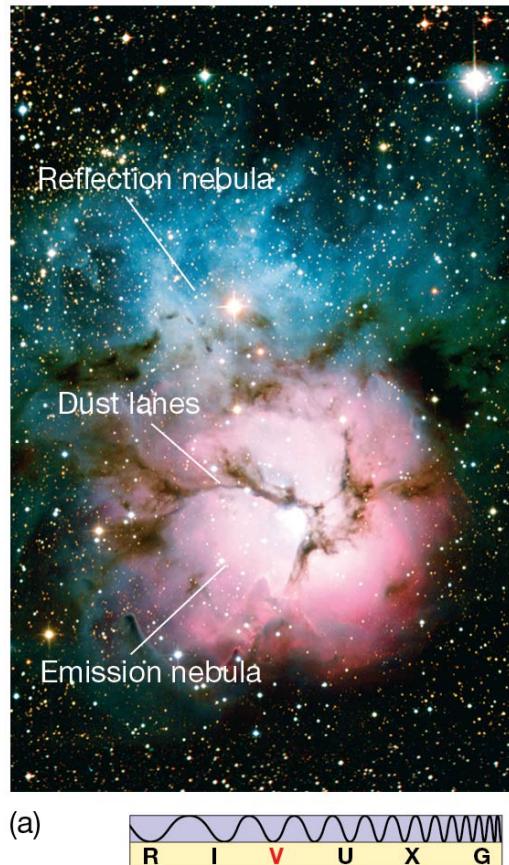


MACAM-MACAM NEBULA

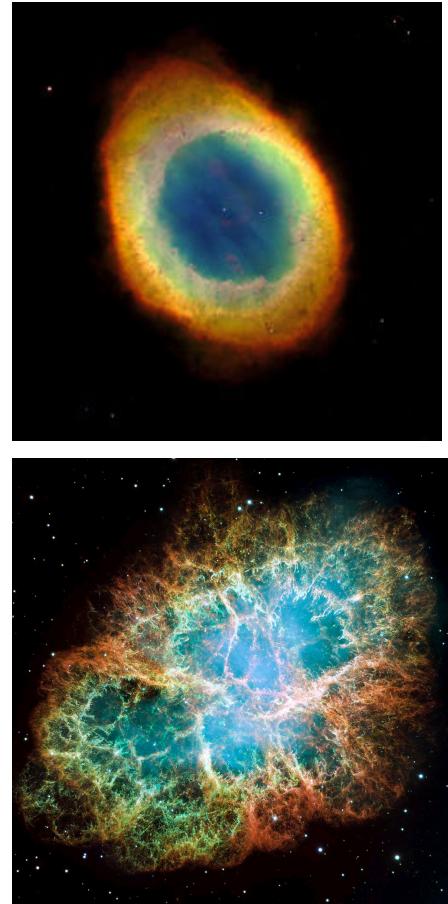
- Nebula awan gelap (*dark cloud*)
- Nebula refleksi
- Nebula emisi
- *Planetary Nebula*
- *Supernova Remnant*



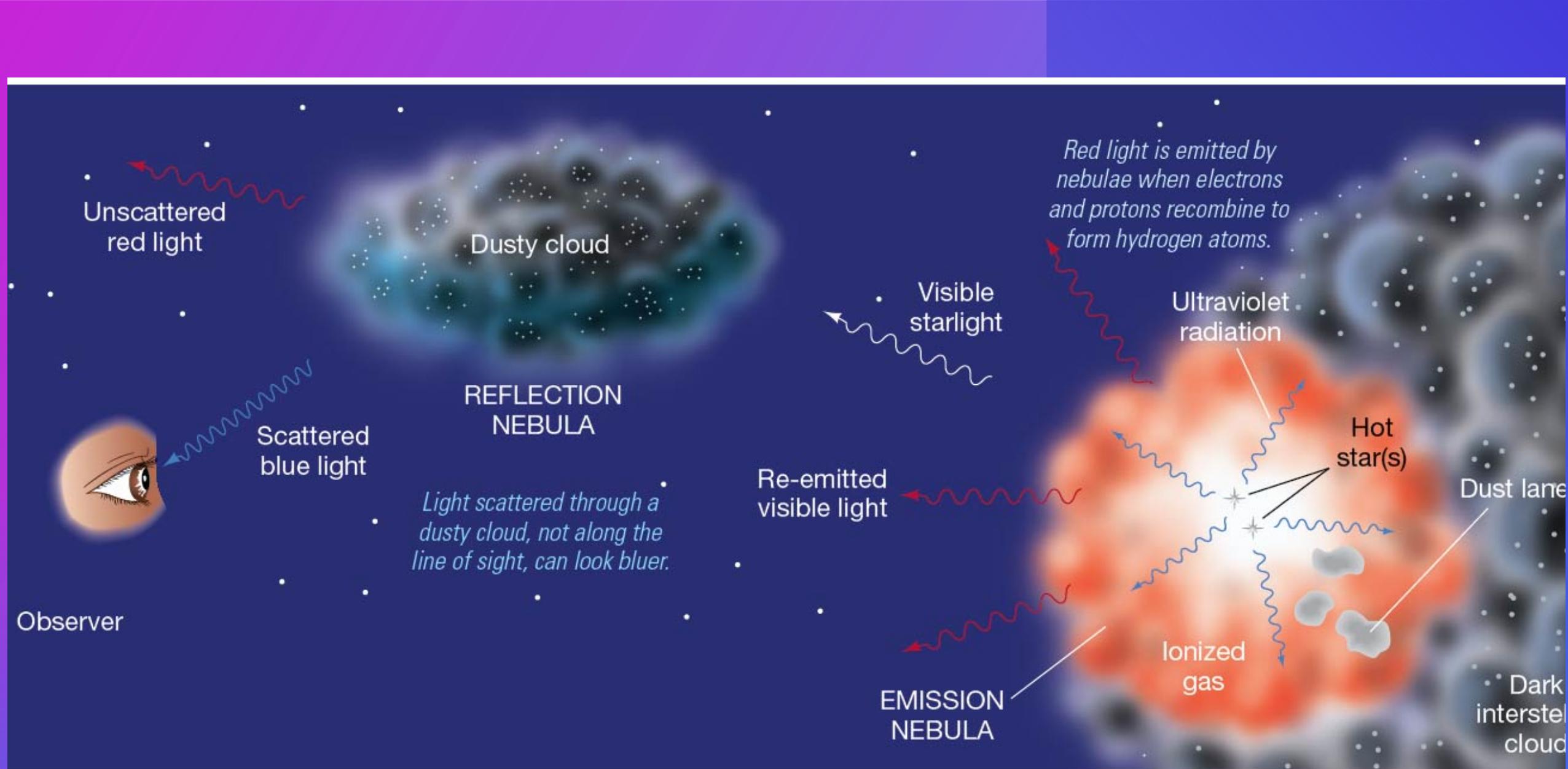
Sumber Gambar: ESO

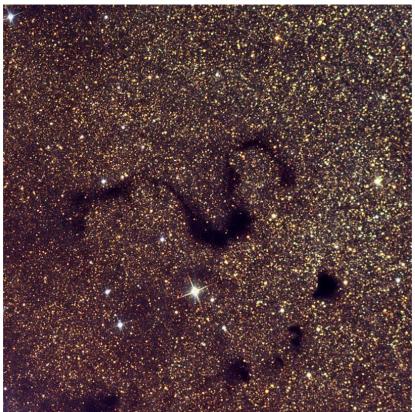


Sumber Gambar: Pearson



Sumber Gambar: NASA, ESA

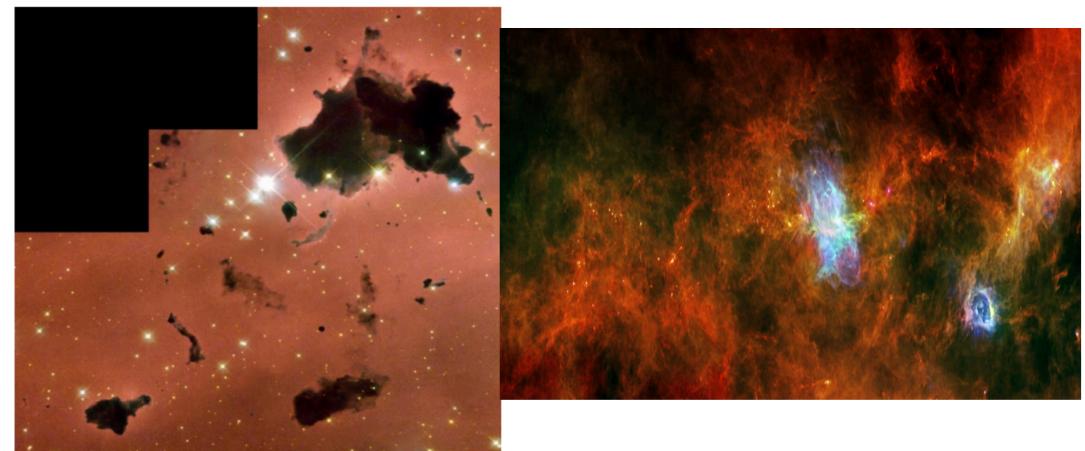


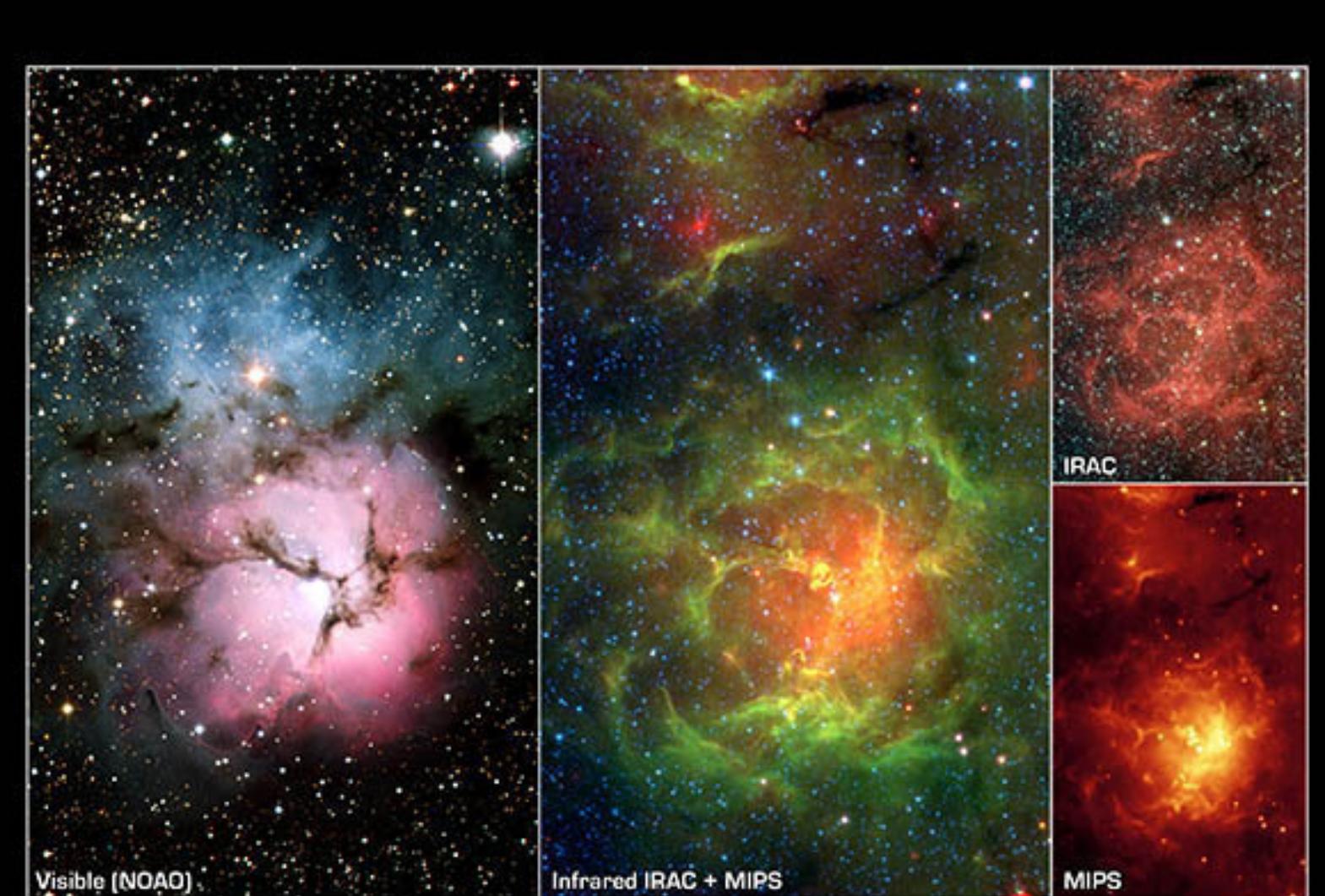


DETEKSI DEBU

- *Interstellar Extinction*
- Emisi debu

Interstellar extinction Interstellar Emission





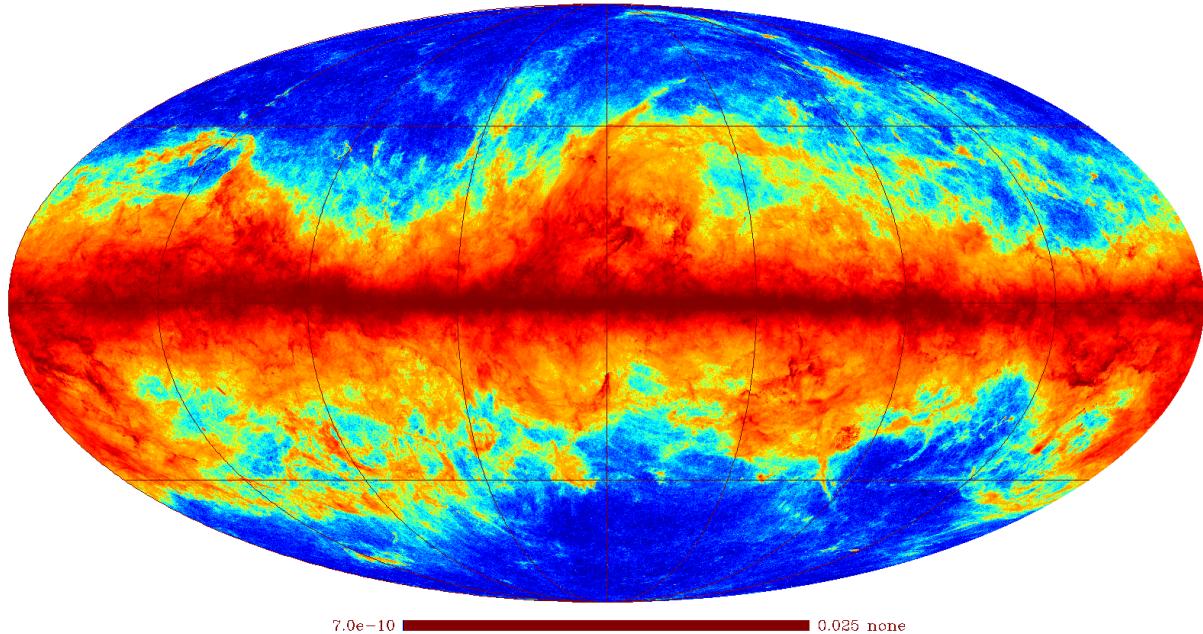
Trifid Nebula/Messier 20
NASA / JPL-Caltech / J. Rho (SSC/Caltech)

Spitzer Space Telescope • IRAC + MIPS
ssc2005-02a

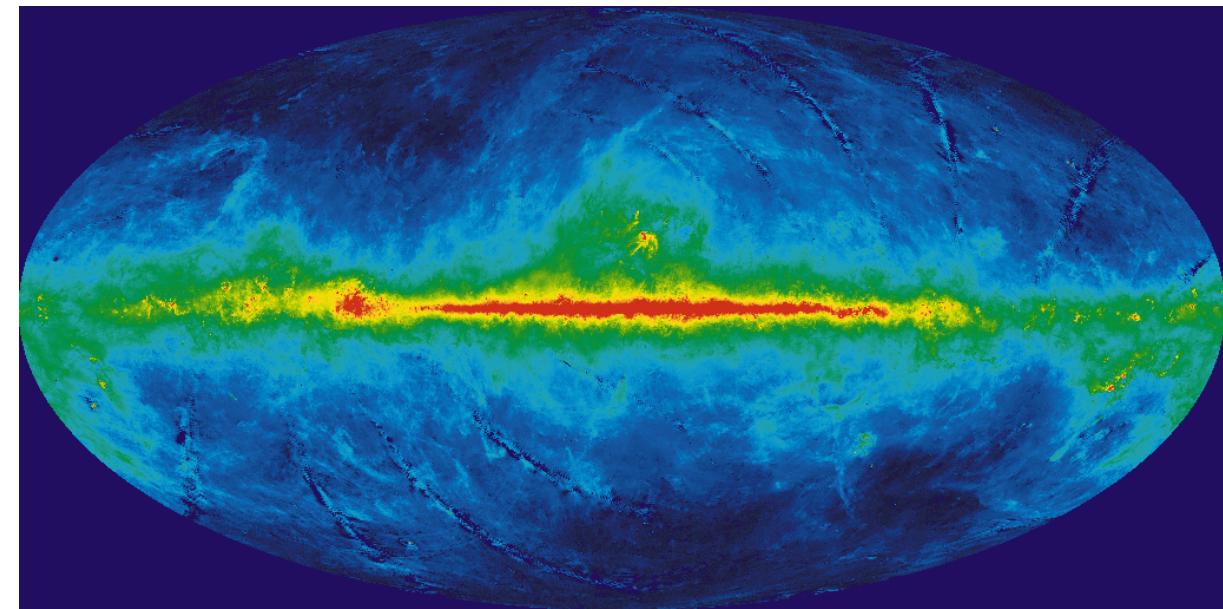
PETA EMISI DEBU

HFI_CompMap_ThermalDustModel_2048_R1.20 TAU353

2048 NESTED GALACTIC



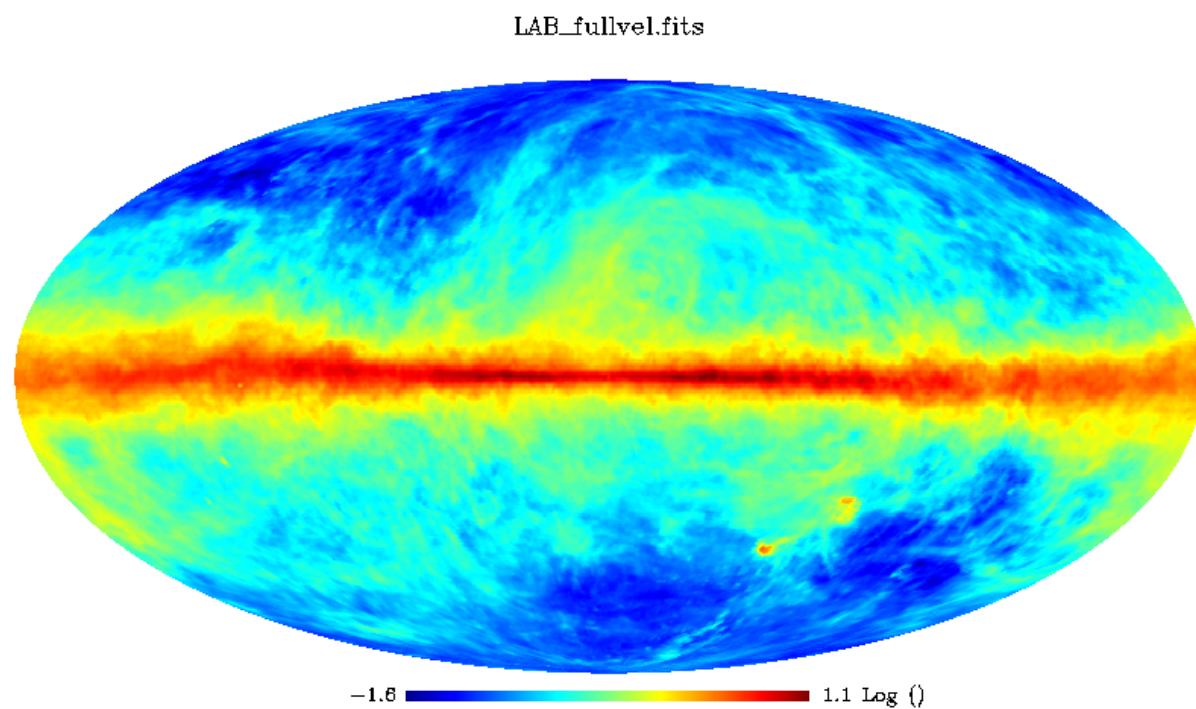
Sumber Gambar: Planck



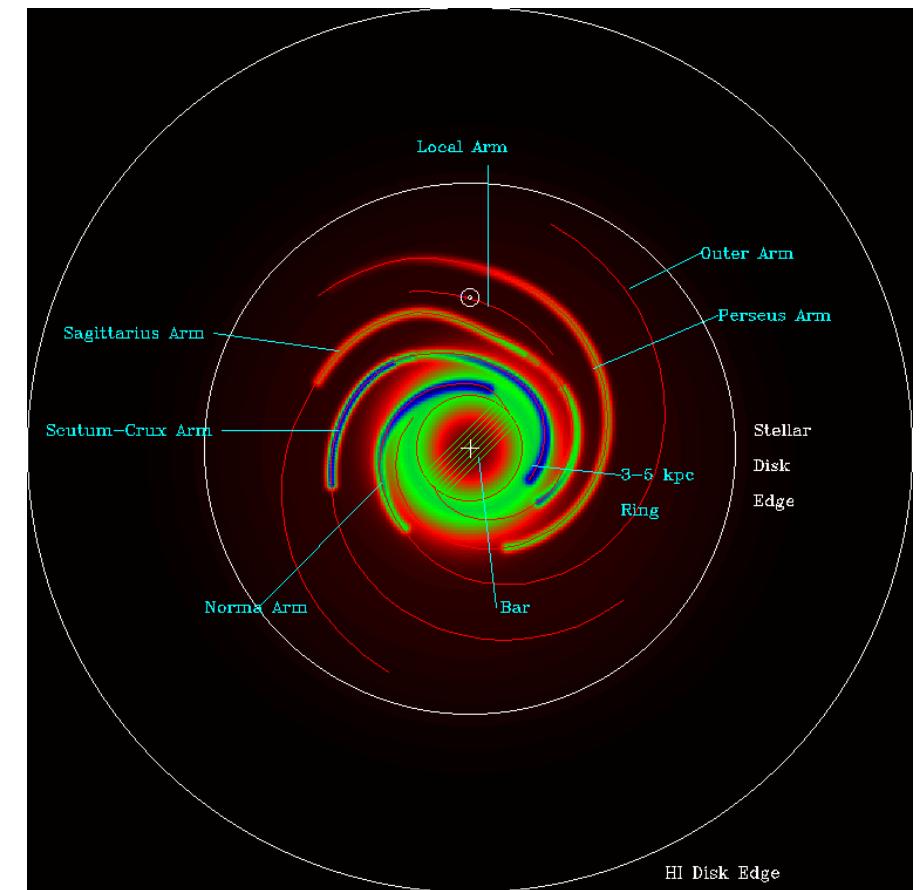
WISE 12 micron dust map.

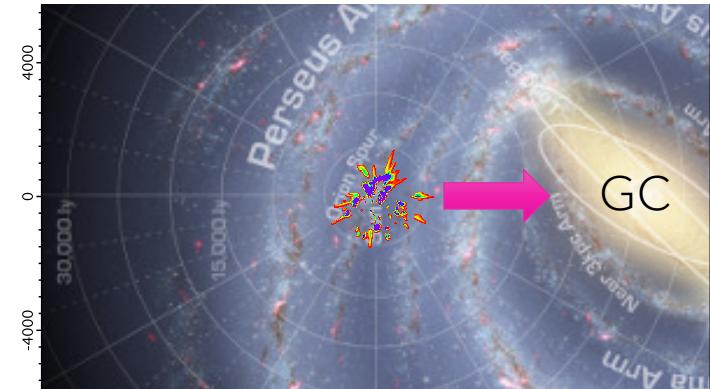
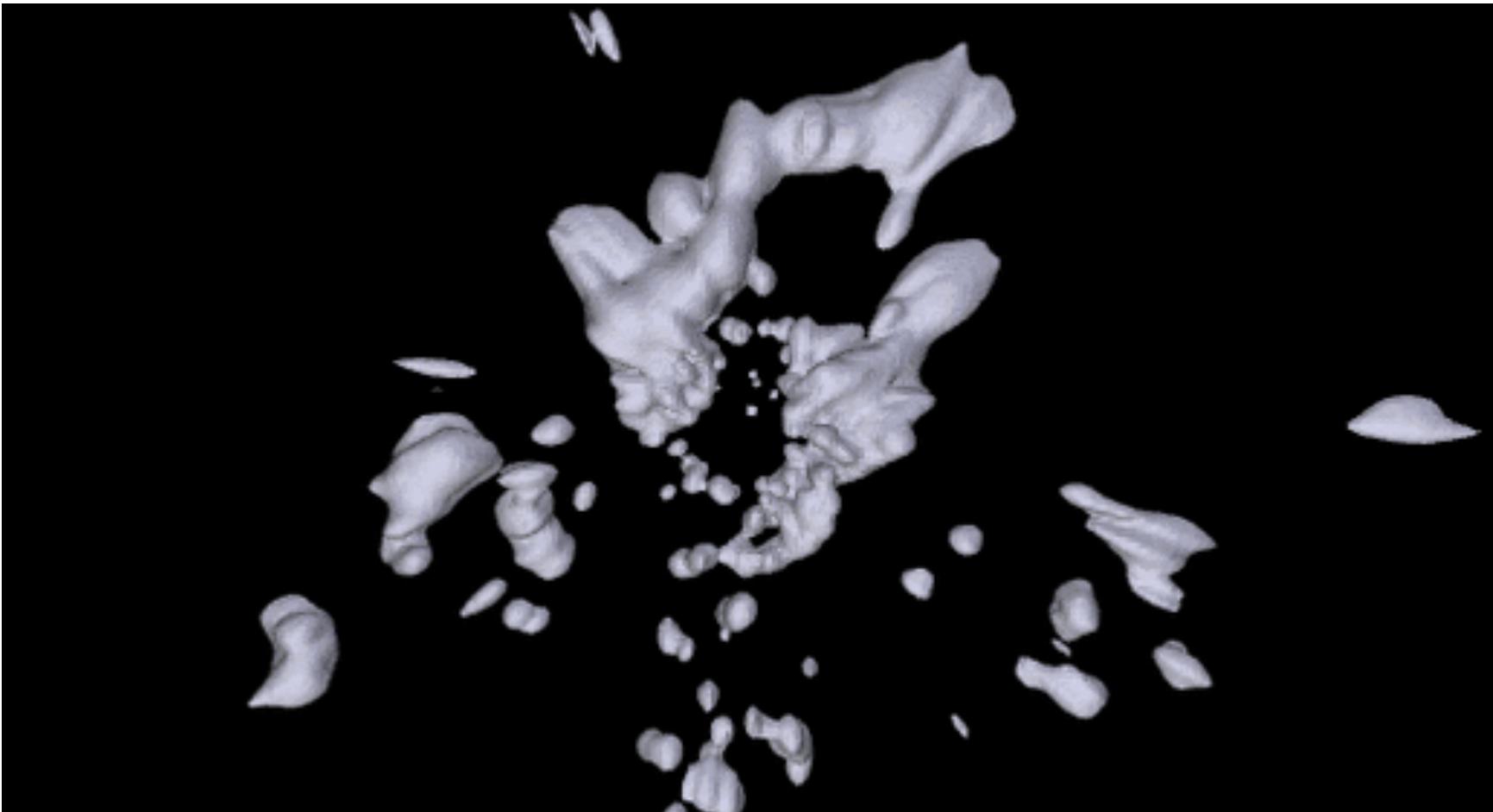
Sumber Gambar: <https://lambda.gsfc.nasa.gov/>

PETA GAS HIDROGEN



Kalbera, P.M.W. et al. 2005 A&A 440 775

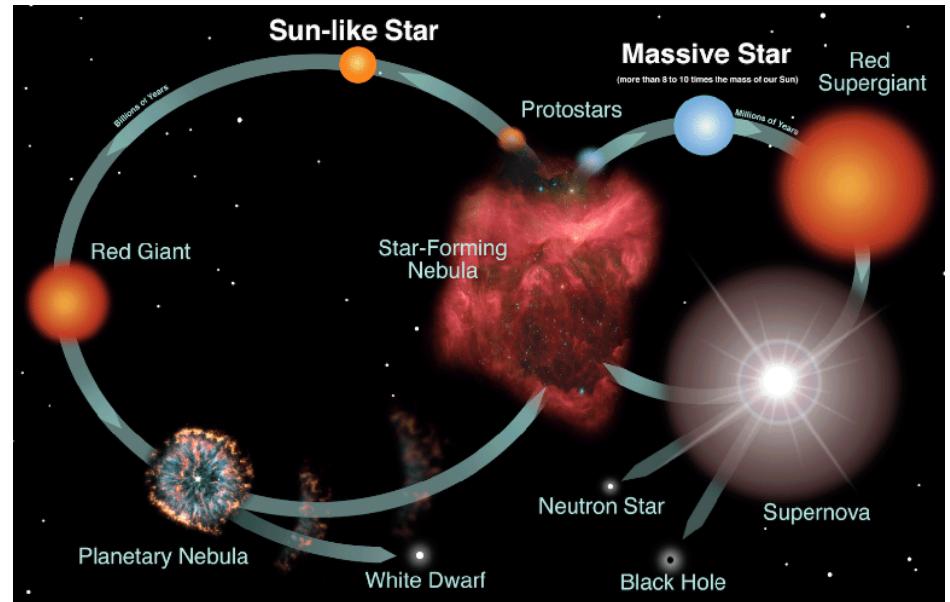




Peta MAB 3D oleh Lallement et al 2014
<https://sketchfab.com/lucky.puspitarini>

AWAN MOLEKULAR

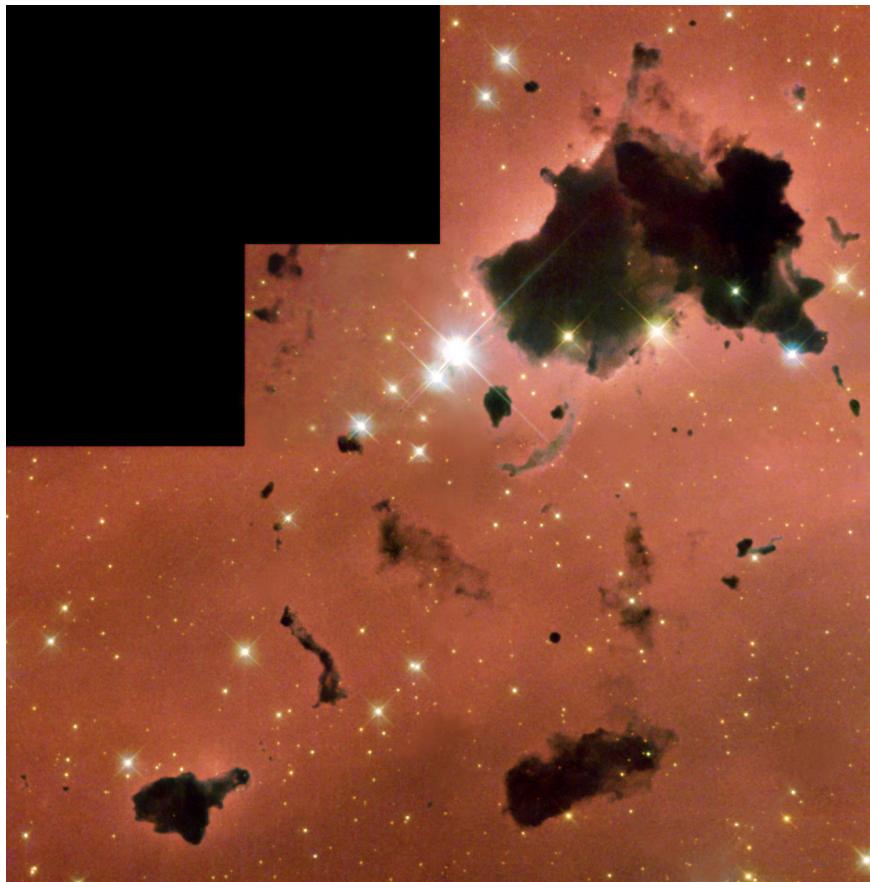
- Awan antarbintang (gas dan debu) dingin yang komposisi utamanya yaitu molekul hidrogen H₂
- Sangat penting → awan pembentuk bintang
- Daerah awan molekular yang sangat rapat yaitu awan gelap (*dark cloud*)



Nebula Elang merupakan bagian dari awan molekular yang berdiameter 20 tahun cahaya.

Sumber Gambar: T. A. Rector & B. A. Wolpa, NOAO, AURA

BOK GLOBULES



Sumber Gambar: Hubble Space Telescope

- *Bok globules* merupakan nebulosa gelap yang terisolasi

A wide-angle photograph of a dark night sky filled with numerous stars of varying brightness. In the lower portion of the image, the dark silhouettes of mountain peaks are visible against the starry background. A single, prominent acacia tree stands in the foreground on the right side, its twisted branches reaching out towards the left. The overall atmosphere is one of tranquility and natural beauty.

Enjoy the beautiful night sky!

TERIMA KASIH