Star Counts

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Definition

Counting the number of stars per unit area on the sky, when compared to the equivalent “star count” in an adjacent region of the sky, can illustrate the presence of extinction by ► interstellar dust.

See Also

► Extinction, Interstellar or Atmospheric
► Interstellar Dust

Star Dust

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Keywords

Infrared spectroscopy; Evolved stars; Stellar winds

Synonyms

Circumstellar grains

History

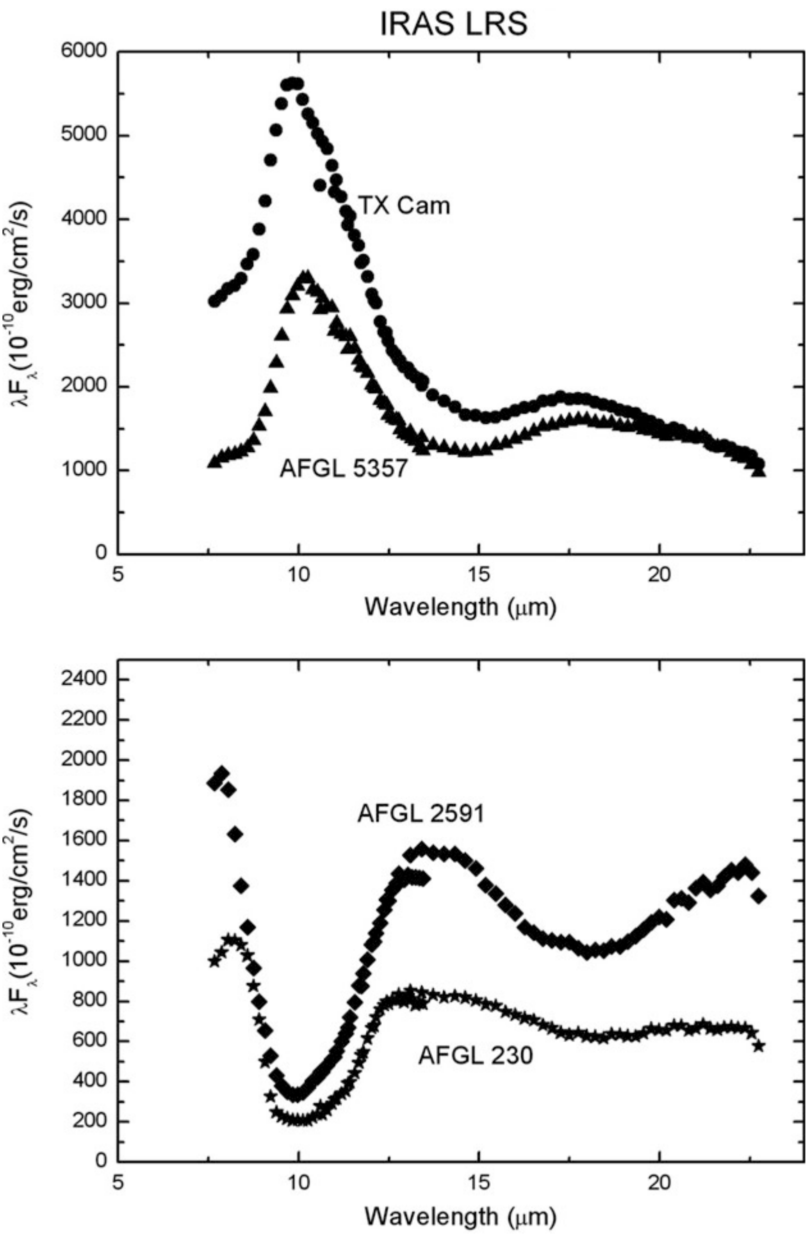
The fact that stars can manufacture solid-state particles in large quantities (stardust) was first recognized through the discovery of infrared excess in the spectra of evolved stars. Infrared spectrophotometric observations in the late 1960s have revealed that stars in the ► asymptotic giant branch (AGB) of evolution show excess emission above the stellar photospheric continuum emission (Woolf and Ney 1969). This excess is interpreted as the result of thermal emission by micron-size solid particles (grains) heated by the stellar radiation. These solid particles absorb visible light from the star and reemit the energy in the infrared.

Overview

Stardust also manifests itself through the absorption of starlight. Circumstellar dust can cause very large extinction in the visible. In extreme cases, the entire photospheric output of a star is converted to dust emission, making the star itself extremely faint or even invisible in optical light (Volk et al. 1992). The most well-known examples of such stars are IRC+10216 and AFGL 3068, which are very bright in the infrared but very faint in the visible.

In terms of chemical composition, stardust can be either oxygen rich or carbon rich. The most common kinds of oxygen-rich solid particles are amorphous silicates, which manifest themselves through their Si–O stretching mode at 9.7 μm and the Si–O–Si bending mode at 18 μm. In the *Infrared Astronomical Satellite* (► *IRAS*) low-resolution spectrometer (LRS) all-sky survey, over 4,000 oxygen-rich AGB stars were found (Fig. 1). The most common kind of carbon-rich stardust is silicon carbide, which is detected in over 700 carbon-rich AGB stars (Kwok et al. 1997).

In addition to amorphous silicates and silicon carbide, silicate minerals (olivines and pyroxenes) as well as several refractory oxides are also made in the circumstellar envelopes of AGB stars. A broad feature centered around 13 μm, first discovered by the IRAS LRS, could be due to corundum (α-Al_2O_3, which has a feature at 12.7 μm), glass (amorphous SiO_2, 12.3 μm), spinel ($Mg_2Al_2O_4$, 12.95 μm), or rutile (TiO_2, 13.4 μm). An emission feature at 19.5 μm



Star Dust, Fig. 1 Infrared spectra of amorphous silicates. The 9.7 and 18 μm features of silicates can be seen both in emission (*top panel*) and in self-absorption (*bottom panel*). Data obtained from the low-resolution spectrometer observations from the ▶ *Infrared Astronomical Satellite*

observed by ▶ *ISO* has been attributed to a mixture of Mg-Fe-oxides (e.g., $Mg_{0.1}Fe_{0.9}O$) (Posch et al. 1999, 2002). The detection of minerals in stellar environments has led to the establishment of the field of astromineralogy (Henning 2003).

Stardust of organic composition has also been found in carbon-rich ▶ planetary nebulae. Organic stardust has not been detected in AGB stars, suggesting that these particles are synthesized in the post-AGB phase of evolution, after the synthesis of gas phase molecules such as acetylene and benzene (Kwok 2004).

Stardust can also be found in the vicinity of young stars, Wolf-Rayet stars, planetary nebulae, ▶ novae, and ▶ supernovae. The disc shape of the dust-emitting region around young stars is suggested to be the precursor of the nebula out of which planets form.

The exact mechanism of stardust formation is not known. It is usually assumed that these solid particles are the result of ▶ nucleation through collision of gas-phase molecules. When the particles are far enough from the stellar surface such that the radiation temperature of the particles has fallen below the condensation temperature of the solid, it will condense spontaneously, similar to soot formation in a flame. Spectral monitoring of novae has shown that novae change from a gaseous free-free spectrum to a dust thermal emission spectrum over periods as short as a few days, suggesting that dust can condense in novae ejecta very quickly (Ney and Hatfield 1978).

Stardust is generally believed to be the source of solid-state particles found in the interstellar medium (▶ interstellar grains). Through radiative and physical processes, the morphology and/or chemical composition of stardust may be modified in the interstellar medium. Most interestingly, various presolar grains (SiC, diamonds, corundum, silicates) of stellar origin have been found in meteorites, suggesting that we actually can hold stardust in our hands (Zinner 1998). The presence of stardust in the solar system provides evidence that stardust is sturdy enough to survive its journey through the ▶ interstellar medium.

See Also

▶ Asymptotic Giant Branch Star
▶ Interstellar Dust
▶ Meteorites
▶ Nova
▶ Nucleation of Dust Grains
▶ Organic Dust, Synthesis by Stars
▶ Stellar Winds
▶ Supernova

References and Further Reading

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Star Formation, Observations

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Keywords

Gravitational collapse; Molecular clouds; Interstellar medium; Spectral energy distribution

Definition

Star formation is the process by which dense portions of interstellar ▶ molecular clouds collapse into small regions that become hot enough at the center to initiate the process of nuclear fusion, thereby creating a star. Observations of star formation require all wavelengths from radio to X-ray and help elucidate the processes underlying the birth of both low-mass and high-mass stars.

History

It is worth reviewing a little bit of the history behind the realization that star formation is an