How to determine the chemical and physical nature of distant objects?

Some Residents of our Galaxy

Atoms bond to make molecules

Elements made of atoms, which have symbols:

- H = hydrogen
- He = helium
- C = carbon
- N = nitrogen
- O = oxygen

Compounds made of molecules, which have formulas:

- H₂O
- CO₂
- CH₄ = methane
- NH₃ = ammonia

February 2018
Astrochemistry

The Electromagnetic Spectrum

\[ \lambda \nu = c \]
\[ c = 3.00 \times 10^{10} \text{ cm / sec} \]

The Sun

Wave Characteristics

Spectroscopy

Use prisms, etc. to break-up light into wavelengths (colors).

Measure intensity (brightness) of each wavelength (color) or each frequency.
Bottom Lines

1. Identify the lines ("peaks") of an object’s spectrum and you’ve chemically analyzed that object.

2. Find same elements and many of the same compounds in space and on Earth.

Spectroscopy works for molecules too!

- Aspirin
- Glycolaldehyde
- Ethylene Glycol

An Infrared Spectrum

- Ethyl Alcohol \( \text{CH}_3\text{CH}_2\text{OH} \)

Carbon Monoxide (CO)
Planetary Formation and Evolution

Now Apply All This Stuff

Forming Planets
Start with Dark Clouds

B68, An Absorption Nebula
500 LY Away (32 million AU)
~ 1 LY Across

Dark Clouds Contains Molecules!

Many Molecules Found in Them

Big Dark Clouds Gravitationally Unstable ... Collapse

Solar System Formation
A Family Planetary Portrait

Worlds of Rock  Worlds of Gas

Sources of Material

Most of the images used here are either original, from our class’s textbook, or in the public domain. Material not fitting into these categories has been credited in cases where I knew the sources. The figures showing the three types of spectra are from the August, 2004 issue of Sky & Telescope magazine. Several images are from the Astronomy Picture of the Day web site. I will be glad to add any other credits missed.