with a twinkle in his eye, offers another explanation which he says "I feel rather strongly about." It is his view that these diffuse lines are due to a gas, just as are the sharp lines in the absorption spectra. Molecular ions, such as the methane ion (CH_4+), present, in Dr. Herzberg's opinion, one of the possibilities for the interstellar species responsible for the diffuse lines. He is testing his theory analytically by attempting to "manufacture" spectra giving diffuse lines identical with the interstellar lines.

There are indications that methane (CH_4), the parent species of CH_4+, is present in the medium and studies already underway may provide full confirmation of this.

"The beauty of the stellar medium as a chemical laboratory is that there are essentially no collisions taking place; those which do occur do so in in absence of external walls," Dr. Herzberg points out. "In addition, the spectrum of a molecule under the low temperature conditions of interstellar space are less complicated than ordinary spectra – only single lines are observed and need to be accounted for, not 50 to 100 making up a band, as is the case in earth-bound spectroscopy."

Within the scope of his fundamental research on the spectra of free radicals, Dr. Herzberg also intends to examine possibilities of finding spectral indications of species – methylene and methyl radicals (CH_2 and CH_3) – which would come from the parent CH_4 in the interstellar medium. Dr. Herzberg was the first to obtain spectra of these secondary species in the laboratory. Although they have not yet been observed in the interstellar medium, the expected region for observations is blocked out by absorptions of the earth's atmosphere. Only spectroscopes installed in satellites can do the trick. Dr. Herzberg believes scientists are close to the answer to one of the most challenging problems in astronomy.

Dr. Herzberg has had a long standing interest in detecting molecular hydrogen in the atmospheres of the outer planets with the aid of the spectroscope. In an important theoretical advance, he postulated the existence of a new kind of spectrum for molecular hydrogen based on consideration of the rotation of these molecules. Ten years later he succeeded in producing this spectrum in the laboratory with the aid of the world's longest absorption tube (creating conditions similar in effect to those giving rise to the absorption spectra from planetary atmospheres). Subsequently, astronomers observed these same spectral lines in the spectrum of Jupiter.

Uranus presented a different problem. Scientists suspected molecular hydrogen to be present but were unable to prove it. Dr. Herzberg was able to show that a diffuse feature observed by Kuiper was due to H_2 by demonstrating that a molecular hydrogen absorption spectrum taken in the laboratory using a long absorbing path at a high pressure and very low temperature had an identical feature.

An elusive molecule in comets has also been tracked down by Dr. Herzberg. Long after the extraterrestrial origin of comets had been recognized, their nature remained a riddle – until their spectra were studied. The spectrum of a comet is almost entirely a molecular emission spectrum consisting mainly of well-known spectra previously observed in the laboratory. One spectral band, however, resisted all attempts at identification until Dr. Herzberg reproduced it in the laboratory. Subsequently, his colleague, Dr. Douglas, showed it to be due to a radical made up solely of three carbon atoms. Dr. Herzberg points to this as an excellent example of the importance of laboratory spectroscopic work in trying to identify features observed in astronomical spectra.

Besides exploring the stars, spectral analysis is basic to many chemical and industrial processes and a powerful tool in applied research. It affords rapid non-destructive quantitative and qualitative analysis of molten steel samples, for example. The spectral fingerprints tell the industrial chemist which elements are present and in what quantities. They serve a different purpose for the pure physicist. The uniqueness of spectra make him wonder why one spectral pattern occurs rather than another. Finding answers to this question leads to a better understanding of the structure of matter. □

Spectral analyses of the space between the stars show small amounts of sodium iron, calcium and titanium as well as hydrogen. But the origin of the diffuse lines in the spectrum has yet to be determined. (Photo of spiral nebula in *Canus Venatici*).

D'après les spectres, l'espace entre les étoiles contient les éléments suivants: fer, sodium, titane, calcium et hydrogène. Toutefois, reste à savoir l'origine des raies diffuses dans ces spectres. (Photo d'une nébuleuse spirale dans Canus Venatici).