1. INTRODUCTION

Space has been the source of inspiration for human beings since time immemorial but until the time of Galileo, Copernicus and Kepler culminating in Newton’s gravitational studies it had only a mystical dimension. Since then careful scientific studies became the seed for some of the most important scientific advances. The work of Fraunhoffer on stellar spectra signaled the real beginnings of astrophysics. An important step in our understanding of interstellar material was made by Hartmann who in 1905 detected the presence of atoms in the heralded the start of molecular studies in the interstellar medium (ISM). The mysterious diffuse interstellar bands (DIBs) have also fascinated scientists since 1919 and the UV hump at 217 nm, detected much more recently (but still when it was 2170 Å) has been a similar source of inspiration. The detection of CH, CH+ and CN in the 1930’s and the detection of C3 and other species in the spectra of comets heralded the start of molecular studies in the ISM and did whet the appetite for further understanding of such matters as the Origin of Life. It was in 1967 Townes and co-workers made the groundbreaking radio studies, which showed that ammonia and water were abundant in the interstellar medium. These experiments opened up a veritable Pandora’s box and laboratory microwave spectrosocpitists (like Takeshi Oka and me) and radioastronomers (such as our Canadian colleagues)
formed collaborations to seek and identify as many interstellar molecules as possible.

2. CARBON CHAINS

At about the same time (1974) an undergraduate Anthony Alexander, David Walton and I, were studying long chain carbon molecules by spectroscopic techniques including laboratory microwave spectroscopy. This work led to a collaboration with Takeshi Oka (now at Chicago) and astronomer colleagues Lorne Avery, Norm Broten and John McLeod at the National Research Council in Ottawa Canada to see if we could detect the molecule HC$_3$N. It seemed a long shot at the time as rough estimates based on the abundances of the other observed molecules suggested that it was likely to be so rare that radioastronomy techniques were unlikely to have sufficient sensitivity. Amazingly the molecule was quite readily detected and much more abundant than expected – at least in some regions of the galaxy. Between 1975 and 1979 we were able to show that the long carbon chain polyynes HC$_n$N ($n = 5, 7$ and $9$) were relatively abundant in some of the dust clouds that pervade the space between the stars in our galaxy.

3. CARBON STARS

Then the fascinating old carbon-rich red giant IRC+10216 was discovered by infrared astronomy and radio studies indicated that it was surrounded by an expanding shell of dust and gas, which was extremely rich in these carbon chain molecules as well as copious amounts of dust – presumably carbon dust. It was quite close and relatively easy to study in detail.

3.1 Theories of Molecule Production in ISM

At the time the most accepted theories of interstellar molecule production were the Ion-Molecule Reaction theory of Bill Klemperer and Eric Herbst and various Grain Surface Catalysis theories. The laboratory studies of David Smith and Nigel Adams added convincing support for the likelihood that the former approach could explain the existence of many of the molecules detected in the ISM. The latter Grain Surface Catalysis explanation also seemed quite convincing