Scientific Highlights:

From graduate school days, I have enjoyed studying regions of cold gas and molecules. I find that the materials are physical conditions are most fascinating.

I judge that my most significant scientific effort has been my work on polluted white dwarfs. Because of their high gravity, these stars normally have very simple spectra – either pure hydrogen, or, more rarely, pure helium. The usual explanation is that gravitational settling is so powerful in these stars that heavy elements sink below the outer mixing zone. There are, however, some conspicuous exceptions. Further, when examined sufficiently closely, perhaps as many as 50% of these stars are externally-polluted.

There are two obvious sources of this pollution: the interstellar medium and the star's own planetary system. Until about 10 years ago, the more popular view among the few people who cared was that we are witnessing interstellar accretion. This is a plausible theory. Standard accretion theory predicts that the white dwarfs would be polluted by interstellar matter.

In 1987, in a search for brown dwarfs, Zuckerman and Becklin discovered an infrared excess around G29-38. Several years later, Graham et al. showed that the excess is due to dust, likely from some destroyed parent body. However, they did not have a good idea how this happened.

Since 1984, I had been a member for the Science Working Group for the NASA SIRTF project. In preparation for the launch, I wrote a paper in 2003 proposing that the infrared excess around G29-38 could be well reproduced by a geometrically thin dust disk that simply reradiated light from the central star. This disk was computed to be inside the tidal radius of the white dwarf and the suggestion is that we are witnessing a system where the tidal destruction of an asteroid has occurred. We now know of about 40 white dwarfs with dust disks and pollution. The story has become more complex, but the basic scenario remains.

This paper has proven to be influential and it is now the "standard model" to explain polluted white dwarfs. What is particularly remarkable about this work is that we now can measure detailed elemental compositions of extrasolar planetesimals. Some highlights include:

- The Earth is 98% by mass composed of oxygen, magnesium, silicon and iron. Carbon is less than 0.1% of the mass. Extrasolar planetesimals display a very similar pattern although the relative abundances of the 4 dominant elements vary.
- Igneous differentiation appears to have proceeded among many of the parent bodies. That is, there is evidence for the formation of iron cores. We study objects nearly as iron-rich as the planet Mercury and nearly as iron-poor as the Earth's Moon.

While I have worked on a number of different projects, the contribution to measuring the compositions of extrasolar planetesimals will probably be most memorable.