Abstract

Spectroscopy is becoming a lost art in the AMO community. For the layman, it is a mess. But not to Ugo Fano. He likes spectroscopy. In particular, he likes the spectroscopy of overlapping Rydberg states of atoms and molecules. Beyond the complicated spectra, he sees the underlying simplicity. He introduced the concept of "frame transformation" in 1970 which forms the basis of the study of Rydberg states of complex atoms and molecules. In the correct frame, the complex spectra becomes the study of the physics of a Rydberg electron in terms of a few parameters. To me, this is precisely what physics is all about. To describe the orbit of a planet from the earth is very complicated. To do so from the center of the sun is much simpler. A theoretical physicist’s role is to provide such a framework, to find the proper “language” such that physical phenomena can be understood by the human mind.

Many people remembered Fano’s famous sentence: “what is new?”, in the morning. However, the sentence that has the most impact on me was: “That is not even wrong!”. He does not just teach you how to solve problems, he taught you HOW to do physics. I have not been “frame transformed” by him, but I have been put into hyperspherical space from the very beginning. The starting point was the spectra of doubly excited states of helium. I would equate that experiment of Madden and Codling to the more famous Michelson-Morley ether experiment. I would also equate Fano’s hyperspherical approach to Einstein’s theory of relativity. A single set of experimental data would lead him to give up the shell model of atoms completely and make him start a new direction. I was fortunate to continue this line of investigation in my career. The hyperspherical method provides a unified theoretical approach for treating atoms and molecules and many problems in between. It has been used to study multiply excited states of atoms, small clusters and three-body recombinations as reported in this conference. I may want to point out that it has also been used to study positron-atom collisions and most recently in
ion-atom collisions. The latter is an old subject but has never been done correctly.

This session is on Rydberg states in matter and antimatter. Rydberg states are formed by a very wimpy slow electron hanging too far and too long away from the nucleus. They got into the way before the electron is ionized. Not any more. They are everywhere. They are formed any time you have recombinations at low temperatures. With the new technology, Rydberg atoms can be made really cold. A little bit of photon energy can ionize the electron, but it can recombine back as well. There is a lot to learn from such ultra-cold plasma. We are to hear the report from an experimentalist Killian and a theorist Robicheaux on this subject. All the interesting matter these days you have to make it yourself. For Gabrielse, the interesting matter is antimatter. He will tell us if he has made the antihydrogen, and what role the Rydberg states play in his experiment.