Speech of

Prof. T.W. Hansch

at the ceremony of awarding him the Prize

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Your Royal Highness, Prince Abd Allah Ibn Abd Al-Aziz,
The Crown Prince,
Your Highnesses, the Princes,
Your Eminencies & Excellencies,
Distinguished guests,
Ladies and gentlemen,

It is a great honour and obligation for me to be named co-recipient of the 1989 King Faisal International Prize for Science. At first I was simply overwhelmed when I learned that I would receive this prize from the King Faisal Foundation, whose noble and inspiring humanitarian goals I admire. But then I felt humbled when I considered the stellar achievements of prior recipients of this prestigeous award, and I also realized how many of my own accomplishments I owe to sheer luck: the luck of working with inspiring and congenial mentors, colleagues and students, the luck of being in the right field at the right time, and the luck of discovering something new that others have found interesting and useful.

I wish I could claim that it has always been my goal to provide some tangible benefits to mankind. However, the truth is that much of my research has been motivated by simple curiosity and fascination with new technology, It is again largely a matter of luck if some of the laser methods I was able to develop have become useful tools for different areas of applied research.

Much of what we know about the structure of matter has been learned by spectroscopy, i.e. studying how matter absorbs or emits different wavelengths or colors of light. More than a century ago, the sharp spectral lines of atomic or molecular gases were first discovered. When scientists developed spectrometers of high resolving power to study the details of such spectra, they soon encountered a serious limitation, the Doppler broadening of spectral lines. In a gas, where the molecules are relatively free and undisturbed, they are inevitably moving about at random with large thermal velocities. Atoms moving towards an observer appear to emit or absorb light of higher frequency than atoms at rest, and atoms moving away appear to emit at lower frequencies. As a result, the spectral lines appear blurred, and important details are often obscured and masked.

In the late l960s, optical spectroscopy was revolutionized by the advent of lasers, intense sources of coherent light that can be extremely monochromatic. I was fortunate enough to take part in the development of several methods which exploit the unique properties of laser light to eliminate the Doppler broadening of spectral lines. In one such method, saturation spectroscopy, a monochromatic beam excites only those atoms in a gas that are standing still or are, at most, moving sideways. A second, counter propagating probe beam can then record a spectrum of these ‘labelled’ atoms that is free of Doppler-broadening.

At first, such Doppler-free spectroscopy could only be performed at a few selected wavelengths with gas lasers. But in the early 1970s, we learned how to make widely tunable dye lasers so monochromatic that Doppler-free saturation spectroscopy and other new methods of laser spectroscopy could be applied at any wavelength from the near infrared to the near ultraviolet.

It is true that these new tools have revealed a bewildering complexity in the spectra of molecules. However, my coworkers and I have become even more fascinated by a different goal. We are applying the sharpest tools spectroscopists can device to study the spectrum of the simplest of all stable atoms, hydrogen. In the past, spectroscopy of hydrogen has played a crucial role in the development of atomic physics and quantum mechanics. As the rosetta stone unlocked the secrets of Egyptian hieroglyphics, the Balmer spectrum of hydrogen opened up the laws governing atoms and eventually molecules, liquids, and solids. More than once, seemingly minute discrepancies between experiment and theory led to major breakthroughs in our fundamental understanding of the microscopic world.

The first laser studies of hydrogen date back to 1971, when I collaborated at Stanford with a bright Egypt-born graduate student, Issa Shahin, on saturation spectroscopy of the red Balmer-a line. We were thrilled when we resolved the Intricate fine structure and we. observed the famous Lamb shift directly in the optical spectrum. Three years later, Munir Nayfeh, another very talented Arabian student, completed his thesis research with a precise absolute wavelength measurement of Balmer at that yielded a much improved value of the Rydberg constant.

Since then, several laboratories in different parts of the world have achieved much progress. Nonetheless, high resolution laser spectroscopy of hydrogen continues to hold fascinating challenges. Some extremely sharp resonances exist, which motivate us to device ever new and better methods for stabilizing lasers, for manipulating atoms, and for measuring optical frequencies. if theory is correct, future experiments will yield much improved values of fundamental constant, such as the Rydberg constant, the mass of the electron, or the size of the proton. At the same time, we can hope to test basic laws of physics with unprecedented scrutiny, if past history is any guide, the biggest surprise would perhaps be if we found no surprise.

Today’s recognition by the distinguished King Faisal Foundation provides a wonderful inspiration for my coworkers and me to redouble our efforts towards these scientific goals.