Speech of

PROFESSOR HERBERT WALTHER

Co-Winner of the 1993 King Faisal International Prize

For SCIENCE (Physics)

Your Royal Highnesses,

Distinguished Guests,

It is a great honour and pleasure for me to receive the prestigious King Faisal International Prize. I would like to thank very much the King Faisal Foundation, the Selection Committee, and all the other people involved in the decision making. I am happy to receive this prize together with Professor Steve Chu who has been a good friend and colleague for many years.

One of the basic processes in Physics is the absorption and emission of light by atoms. We know that the spectra of atoms can be used as fingerprints, thus the spectral analysis of substances is a common method to identify trace constituents of materials. At the beginning of the century, the careful study of atomic special lines led to a new model, for the atom having features which later found full justification by the quantum theory developed in the twenties and thirties of our century.

A new era of the investigation of the spectra started when the laser was invented roughly 30 years ago. The laser as a light source with high spectral brightness suddenly allowed many new experiments which previously existed only in the dreams of physicists. I entered this exciting new field as a young postdoctoral student. It was great to learn almost daily about the new applications of the laser and to participate actively in the development of the field.

There was another great step forward when the frequency tunable laser was invented. This system allowed us to tune the laser radiation into resonance with spectral lines of an atom. The tunable dye laser thus made it possible to detect and identify single atoms. The sensitivity of the spectral analysis could so be enlarged by several orders of magnitude. Furthermore, the resolution of the spectra could be increased so that the spectral lines could be studied with much higher accuracy.

This single atom detention is one ingredient of the one-atom maser which has been my main work during the recent years. Another interest has been a super conducting cavity. When an excited atom enters the cavity it is forced to emit a photon which then is stored and kept long enough so that it can be reabsorbed by the atom. In this way the dynamics of the photon-atom interaction can be studied.

The cavity is a cylindrical box which is made of superconducting material that means it has no electrical losses when cooled to low temperatures. If an electromagnetic field is enclosed, this field can be stored for a very long time. Therefore we can do experiments with single light quantas or photons. When an atom enters the box it emits a photon which is then stored until it is absorbed again by the atom. We thus have a theoretically simple and clear system where the phenomenon of emission and the absorption can be studied in much more detail than before.

Moreover the system can be used as a radiation generator. In this case the generated radiation has unique properties: the noise of the field is much smaller than for any other radiation generator we know. This unique property may be very interesting for future applications in telecommunications since the transmitted signals are less noisy, therefore larger distances can be covered with the same output power of the transmitters.

Modern scientific work is pursued interacting with colleagues and coworkers. My work would not have been possible without the help and support I received from many people. I would like to acknowledge this support. Last but not least I would like to thank my family who always supported my work and was understanding when I spent evenings and weekends in the lab instead of being at home.