Prof. Claude Cohen-Tannoudji
Professor, Nobel laureate in Physics, 1997

Most important awards, prizes and academies

Nobel Prize in Physics (1997); Commandeur de la Légion d'honneur; Commandeur de l'Ordre national du mérit; Big Cross of the National Order of the Brazilian Scientific Merit. Academies: Académie des sciences, Paris; National Academy of Sciences, USA; American Academy of Arts and Sciences; Accademia Nazionale dei Lincei, Italy; Académie Royale des Sciences, des Lettres et des Beaux-Arts, Belgium; Russian Academy of Sciences; American Physical Society (1986); American Academy of Arts and Sciences (1992); European Academy of Arts and Sciences; Academia Europaea (1993); National Academy of Sciences, USA (1994); Académie Royale des Sciences, des Lettres et des Beaux-Arts de Belgique (1996); Accademia dei Lincei of Italy; National Academy of Sciences, Allahabad, India (1998); Indian Academy of Sciences, Bangalore (1999); Pontificia Academia Scientiarum; Académie des Sciences, Belles-Lettres et Arts de Lyon; Indian Science Academy of New Delhi (2000); Optical Society of America (2002); Indonesia Physics Society; Brazilian Academy of Sciences (2003).

Summary of scientific research

The scientific problems investigated by Claude Cohen-Tannoudji deal with radiation-matter interactions. With his collaborators he has written five books on quantum mechanics, quantum electrodynamics and quantum optics, and about 200 theoretical and experimental papers on

various problems of atomic physics and quantum optics. During his Ph.D. done under the supervision of Alfred Kastler and Jean Brossel, he predicted that atomic energy levels should be displaced by light and he observed the corresponding light shifts. A few years later, he showed that very narrow level crossing resonances can be observed in atomic ground states and he detected in this way very weak magnetic fields (in the nanogauss range). With his students, S. Haroche, J. Dupont-Roc, S. Reynaud and J. Dalibard, he developed the dressed atom approach for describing atom-photon interactions. This approach has been very useful, not only in understanding in a synthetic way various physical effects in the RF and optical domains (Autler-Townes effect, fluorescence triplet, photon antibunching, intermittent fluorescence, dipole forces ...), but also in discovering new physical effects (cancellation of an atomic g-factor by a RF field, time correlations between frequency filtered photons, Sisyphus effect ...). He developed simple physical pictures for radiative corrections such as the Lamb shift and the spin anomaly g-2. During the last fifteen years, he has made with his collaborators, A. Aspect, J. Dalibard and Ch. Salomon, several contributions to the field of manipulation of atoms by light, such as the Sisyphus cooling mechanism where a moving atom is running up potential hills more frequently than down, or the use of velocity selective dark states for cooling atoms at one, two and three dimensions, below the limit corresponding to the recoil kinetic energy of an atom emitting or absorbing a single photon. Other recent contributions have investigated gravitational cavities for neutral atoms where cold atoms bounce (up to 10 times) off a mirror formed by an evanescent wave, and the quantization of atomic motion and the localization of atoms in periodic optical potential wells. Very recently, his group has observed Bose-Einstein condensation of helium atoms in a metastable state. He was co-laureate of the 1997 Nobel Prize in Physics for the development of methods to cool and trap atoms with laser light.

Main publications

Books: Cohen-Tannoudji, C., Diu, B., Laloë, F., *Quantum Mechanics*, Tomes I and II, Wiley (New York, 1997); Cohen-Tannoudji, C., Dupont-Roc, J., Grynberg, G., *Photons and Atoms, Introduction to Quantum Electrodynamics*, Wiley (New York, 1989); Cohen-Tannoudji, C., Dupont-Roc, J., Grynberg, G., *Atom-Photon Interactions: Basic Processes and Applications*, Wiley (New York, 1992); Cohen-Tannoudji, *Atoms in Electromagnetic Fields*, World Scientific (Singapore, 1994, 2nd ed. 2004); Bardou F., Bouchaud, J.-P., Aspect, A., Cohen-Tannoudji, C., *Lévy Statistics and Laser Cooling*, *How Rare Events Bring Atoms to Rest* (Cambridge, 2001). Articles: Cohen-Tannoudji, C., Dupont-Roc, J., Experimental study of Zeeman light shifts in weak magnetic fields, *Phys. Rev.*, A5, p. 968 (1972); Dupont-Roc, J., Haroche, S., Cohen-Tannoudji, C., Detection of very weak magnetic fields (10-9 Gauss) by Rb-87 zero-field level crossing resonances, *Phys. Letters*, A28, p. 638 (1969); Dalibard, J., Cohen-Tannoudji, C., Dressed-atom approach to atomic motion in laser light: the dipole force revisited, *J.O.S.A.*, B2, p. 1707 (1985); Aspect, A., Dalibard, J., Heidmann, A., Salomon, C., Cohen-Tannoudji, C., Cooling atoms with stimulated emission, *Phys. Rev. Lett.*, 57, p. 1688 (1986); Dalibard, J., Cohen-Tannoudji, C., Laser cooling below the Doppler limit by polarization gradients: simple theoretical models, *J.O.S.A.*, B6, p. 2023 (1989); Aspect, A.,

Arimondo, E., Kaiser, R., Vansteenkiste, N., Cohen- Tannoudji, C., Laser cooling below the one-photon recoil energy by velocity-selective coherent population trapping, *Phys. Rev. Lett.*, 61, p. 826 (1988); Verkerk, P., Lounis, B., Salomon, C., Cohen-Tannoudji, C., Courtois, J.-Y., Grynberg, G., Dynamics and spatial order of cold cesium atoms in a periodic optical potential, *Phys. Rev. Lett.*, 68, p. 3861 (1992); Aminoff, C.G., Steane, A.M., Bouyer, P., Desbiolles, P., Dalibard, J., Cohen-Tannoudji, C., Cesium atoms bouncing in a stable gravitational cavity, *Phys. Rev. Lett.*, 71, p. 3083 (1993); Bardou, F., Bouchaud, J.-P., Emile, O., Aspect, A., Cohen-Tannoudji, C., Sub-recoil laser cooling and Lévy flights, *Phys. Rev. Lett.*, 72, p. 203 (1994); Kulin, S., Saubamea, B., Peik, E., Lawall, J., Hijmans, T.W., Leduc, M., Cohen-Tannoudji, C., Coherent Manipulation of Atomic Wave Packets by Adiabatic Transfer, *Phys. Rev. Lett.*, 78, p. 4185 (1997); Saubama, B., Hijmans, T.W., Kulin, S., Rasel, E., Peik, E., Leduc, M., Cohen-Tannoudji, C., Direct Measurement of The Spatial Correlation Function of Ultracold Atoms, *Phys. Rev. Lett.*, 79, p. 3146 (1997); Pereira, F., Leonard, J., Wang, J., Barrelet, C., Perales, F., Rasel E., Unnikrishnan, C., Leduc, M., Cohen- Tannoudji, C., Bose-Einstein Condensation of Metastable Helium, *Phys. Rev. Lett.*, 86, p. 3459 (2001); J. Léonard, M. Walhout, A.P. Mosk, F. Perales, T. Muller, M. Leduc, C. Cohen-Tannoudji, *Phys. Rev. Lett.* 91 (2003): Giant helium dimmers produced by photoassociation of ultracold metastable atoms; J. Léonard, A.P. Mosk, M. Walhout, P. van der Straten, M. Leduc, and C. Cohen-Tannoudji, *Phys. Rev.* A69, (2004): Analysis of photoassociation spectra for giant helium dimmers; J. Kim, S. Moal, M. Portier, J. Dugé, M. Leduc et C. Cohen-Tannoudji, *Europhys. Lett.* 72 (4) (2005): Frequency shifts of photoassociative spectra of ultracold metastable helium atoms: A new measurement of the s-wave scattering length; C. Cohen-Tannoudji, *et al.*, La condensation de Bose-Einstein dans les gaz, Einstein aujourd'hui, *EDP Sciences* (2005); C. Cohen-Tannoudji et J. Dalibard: Manipulating atoms with photons, *The New Physics for the Twenty-First Century*, ed. G. Fraser, Cambridge University Press (2005); C. Cohen-Tannoudji: Qu'est-ce que la lumière pour le physicien d'aujourd'hui?, La Lumière au siècle des Lumières & aujourd'hui, *Art et Science*, Odile Jacob (2005); S. Moal, M. Portier, J. Kim, J. Dugué, U.D. Rapol, M. Leduc and C. Cohen-Tannoudji, *Phys. Rev. Lett.* 96 (2006): Accurate determination of the scattering length of metastable Helium atoms using dark resonances between atoms and exotic molecules; M. Portier, S. Moal, J. Kim, M. Leduc, C. Cohen-Tannoudji and O. Dulieu: Analysis of light-induced frequency shifts in the photoassociation of ultracold metastable helium atoms, *J. Phys. B*, 39 (2006).