By loading both clouds of atoms from a magneto-optic trap (MOT) into a magnetic trap (where both species are spin polarised), we probe the suppression of Penning ions. Within the noise levels of our experiment we observe no increase in Penning ion production due to the presence of rubidium thus demonstrating at least a factor of 100 suppression in Penning ions due to spin polarisation. In the future we will attempt to create the first excited-state/ground-state Bose-Einstein condensate mixture. Hopefully, our initial measurements will stimulate interest amongst scattering theorists, as little is known about the molecular interactions of ultracold He* and rubidium. ■

■■■ **L.J. Byron**, **R.G. Dall**, **Wu Rugway** and **A.G. Truscott**, 'Suppression of Penning ionization in a spin-polarized mixture of rubidium and He*', *New Journal of Physics* **12**, 013004 (2010)

STATISTICAL PHYSICS

Logical independence and quantum randomness

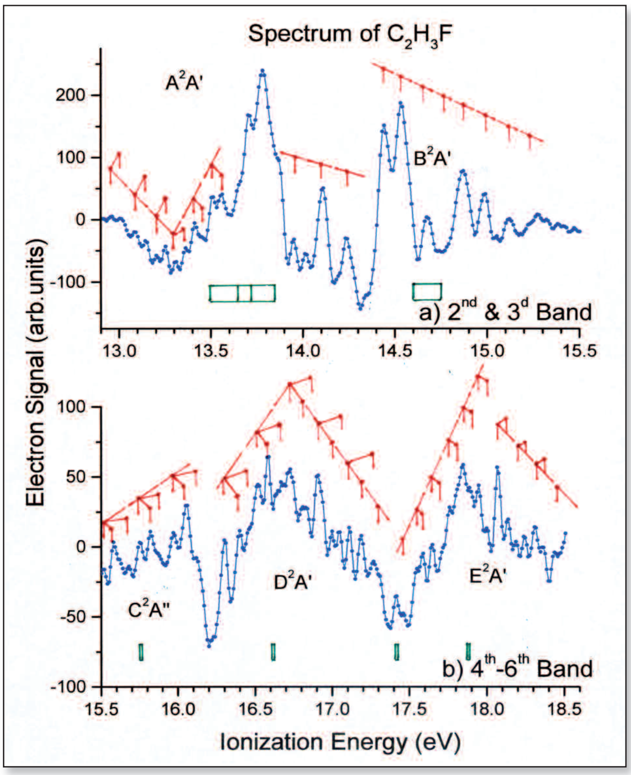
Imagine a game show with a candidate and a quiz master. Unfortunately, the candidate has a storage capacity of only one single bit. In other words, he is able to memorize the solution "yes" or "no" to only one single binary question. The rule of the game is that the candidate cannot refuse a question and has to give an answer to every yes-no question he is asked by the quiz master. Say, the candidate starts with the one-bit knowledge that the statement "France is in Europe" is true. However, the first question by the quiz master is about a *logically independent* statement, namely whether it is true or false that "Gordon Brown is Prime Minister of the UK". The poor person only knows about France being in Europe and thus has to randomly guess an answer "yes" or "no".
The situation is similar in quantum mechanics. Electrons, for instance, are spin-1/2 particles, and their spin is always up ("yes") or down ("no") along some direction. If the spin is up along a certain direction, say z, then – due to Heisenberg uncertainty – it is totally undefined along the orthogonal complementary directions x and y. A group of quantum physicists (T. Paterek *et al.*) from the University of Vienna and the Institute for Quantum Optics and Quantum Information (IQOQI) propose to view the electron's situation in the same way as the quiz show candidate. They find a precise link between spin measurements along different directions and logically independent mathematical questions. The electron can encode the answer to only one of these questions. Whenever the experimenter asks a question that is logically independent from that particular one, the outcomes are random, as there is no information whatsoever to specify the result. ■

■■■ **T. Paterek**, **J. Kofler**, **R. Prevedel**, **P. Klimek**, **M. Aspelmeyer**, **A. Zeilinger**, and **C. Brukner**, 'Logical independence and quantum randomness', *New Journal of Physics* **12**, 013019 (2010)

ATOMIC AND MOLECULAR PHYSICS

Autoionization and non-adiabatic coupling in **molecular photoionization**

Understanding chemical reactivity requires a detailed knowledge of reactant properties at the molecular level. Ionic reactivity is at the core of powerful analytical technique such as mass spectrometry. Investigating ion production mechanisms and the partitioning of the electronic and vibrational energy is therefore essential. Photoionization is a convenient way to produce cold as well as excited molecular ions. For many ions, only the properties of the ground electronic state are known in detail. Excited states are nevertheless essential to promote reactivity. The authors present the most detailed investigation to date on the photoionization of vinyl fluoride (C_2H_3F), combining four approaches: photoelectron spectroscopy at 21.21eV, threshold photoelectron spectroscopy (TPES), constant ion state spectroscopy (CIS) and high-level *ab initio* quantum chemical calculations. In addition to extending the knowledge on the ground electronic state, these techniques provide relevant information on six excited electronic states. The focus is on the identification and assignment of the vibronic levels, on the role of autoionization (coupling between neutral excited states and ionization continua), and the identification of non-adiabatic couplings (avoided crossings and conical intersections) between ionic electronic states,



▲ **Electron signal resulting from photoionization to electronic excited states of $C_2H_3F^+$. The vibrational structure (red markers) has been amplified by a continuum subtraction procedure. The green areas locate the fragment appearance energies.**