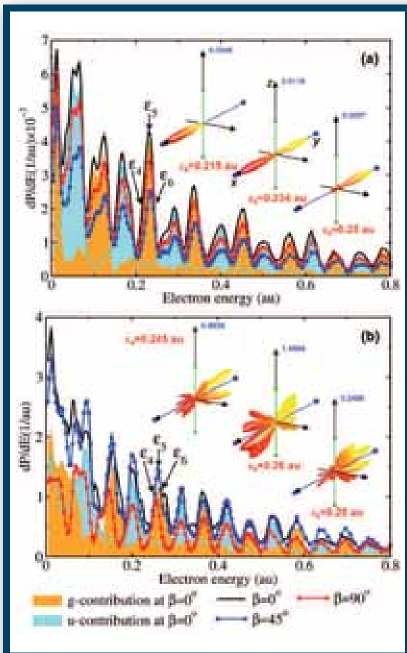
Breaking symmetry **by intense fs laser pulses**

The simplest system exhibiting the chemical bond is H_2^+. Each electronic state possesses a specific inversion symmetry, gerade (*g*) or ungerade (*u*), with respect to the molecular center. Recent work show that symmetry breaking is possible in H_2^+ by the interaction with short laser pulses.



◄ (a) Photoelectron spectrum for the ground *g* state for three orientations β of the polarisation vector with respect to the molecular axis for femtosecond laser ionization. Shaded areas show the *g* and *u* decomposition of the total spectrum. The inserts represent the PAD for a perpendicular geometry at energies indicated. All are normalized to 1 at the maximum of the PAD. (b) Same as (a) but for the first excited u state.

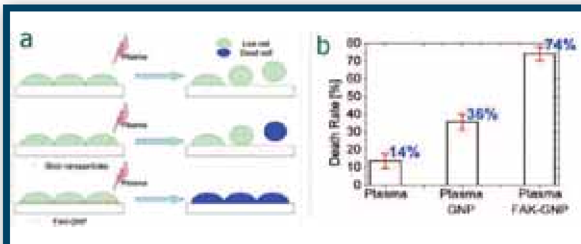
The asymmetry is apparent in the photoelectron angular distribution (PAD) of the ground *g* and first excited *u* state. The PAD presents a forward-backward asymmetry that strongly depends on the final electron energy (see figure). This loss of inversion symmetry results from the entanglement of continuum states with *g* and *u* symmetry – the strict *g* or *u* symmetry is lost The results are based on a new *ab initio* approach combining grid-based and basis state calculations. A striking feature is observed in the PAD from the *u* state: the electron is prevented from escaping in the direction of the field when the molecule is perpendicular to it (see figure). The origin of this anomaly is related to the initial inversion symmetry of the molecule. These mechanisms are general for all molecules under the influence of strong and short laser pulses. ■

▮▮▮ **J. Fernández** and **L.B. Madsen**, 'Energy-resolved photoelectron angular distributions of H_2^+ in intense femtosecond laser pulses', *J. Phys. B* **42**, 021001 (2009).

Antibody nanoparticles: a new weapon against cancer

In our difficult war against cancer (S.Begley, *Newsweek*, Sept. 6, 2008; B.Saporito, *Time*, Sept. 4, 2008) for the past few decades, we have emerged out with a drastically novel therapeutic approach. This uses antibody-conjugated nanoparticles with air plasma. We achieved significant enhancement of melanoma cell death over the case of plasma alone by using air plasma with gold nanoparticles (GNP) bound to anti-focal adhesion kinase (FAK) antibody. Two electrodes covered with a dielectric material were connected to each other to generate plasma. One was connected to a low frequency (22 kHz), high voltage (5 kV) sinusoidal source and the other was grounded. This setup operates in ambient air. G361 human melanoma skin cancer cells were placed 2 mm from the plasma source for 40 s. We used 30 nm GNPs and antibody conjugation to selectively enhance its therapeutic effects. The antibody-conjugated gold nanoparticles (FAK-GNPs) are expected to be not only more lethal but also more selective against G361 cells. Three cell groups were prepared: 1) cultured in only media; 2) cultured in media containing GNPs; and 3) cultured in media containing antibody-conjugated nanoparticles. When the three groups were irradiated by plasma, the cell death rates were 14%, 36% and 74% respectively (Fig.). Our study demonstrates that the antibody-conjugated nanoparticles bind to FAK proteins specifically, irradiation of non-plasma stimulated gold nanoparticles caused deactivation of FAK, thereby increasing the death rate five times. So we can achieve a precise attack against cancer cells using plasma and functionalized conjugates made of GNPs and cancer specific antibodies. This research opens to a new paradigm where non-thermal plasma and antibody conjugated-GNPs team up to create a powerful weapon against cancer. ■

▮▮▮ **G.C. Kim, G.J. Kim, S.R. Park, S.M. Jeon, H.J. Seo, F. Iza** and **J.K. Lee**, 'Air plasma coupled with antibody-conjugated nanoparticles: a new weapon against cancer', *J. Phys. D: Appl. Phys.* **42**, 032005 (2009)



▲ Contribution of FAK-GNPs to dramatic G361 cell death with plasma irradiation. a, Plasma-induced cell death. b, Comparison of cell death rates.