

Chemistry with Cold Molecules: from Universality to Quantum Resonances

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There has been a long-standing quest to observe chemical reactions at low temperatures where reaction rates and pathways are governed by quantum mechanical effects or long range interactions. This field of Quantum Chemistry has been dominated, to date, by theory, with almost no experiments. The difficulty so far, has been to realize low enough collisional velocities between neutral reactants, so that the de Broglie wavelength becomes long enough for the quantum wave nature to emerge as a dominating effect. We will discuss how reaction temperatures on the order of several milli Kelvin can be achieved without laser cooling by merging cold and fast molecular and atomic beams. We will show that by controlling the initial electronic state of metastable helium in the ionisation reactions with molecules we can switch reaction mechanism from the universal Langevin behavior into the quantum tunnelling dominated regime.

1. A. B. Henson, S. Gersten, Y. Shagam, J. Narevicius, E. Narevicius, "Observation of Resonances in Penning Ionization Reactions at Sub-Kelvin Temperatures in Merged Beams", *Science* **338**, 234, 2012

2. E. Lavert-Ofir, Y. Shagam, A. B. Henson, S. Gersten, J. Klos, P. S. Zuchowski, J. Narevicius and E. Narevicius, "Observation of the isotope effect in sub-kelvin reactions", *Nature Chemistry* **6** (4), 332-335, 2014