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Fast pulses and slow atoms: making microKelvin molecules using femtosecond lasers

IAN WALMSLEY, University of Oxford

We discuss a general approach to the formation of ultracold ground state molecules by synthesis from pairs of cold atoms using shaped ultrashort optical pulses. This method combines an effective and widely applicable control technology to the problem of preparing molecules is the ground state of all their degrees of freedom. The broad bandwidth of femtosecond pulses provides and number of options for removing energy from a pair of colliding atoms, and binding them with little or no vibrational energy. We shall give examples of possible strategies, and report on experiments demonstrating photoassocation using coherent control, and measuring wavepacket dynamics by femtosecond pump probe molecular ionization. Prospects for stabilizing the molecules by protecting them from further collisions, and for increasing the range of internuclear separations that can be associated will be pointed out. This work is funded by the UK EPSRC, and has contributions from J. Petrovic, A. Wyatt, A. Dicks, D. McCabe, D. England, M. Friedman, H. Martay, T. Koehler, C. Foot and collaborations with F. Masnou-Seeuws and J. Mur-Petit.