Electronic, optical and vibronic coupling in organic systems from many-body perturbation theory

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The ability of the *GW* and Bethe-Salpeter Green's function many-body perturbation theories to describe the electronic and optical properties of isolated molecules and complexes is being explored by several groups worldwide. While difficulties exist, related e.g. to the starting point dependency, the effect of self-consistency at various levels. or the specific convergence problems for isolated molecules or clusters, we will show that this family of techniques provide reliable results for the description of problematic systems, such as transition-metal containing molecules [1] and the important family of cyanine dyes, [2] or important physical phenomena such as charge transfer excitations [3] and electron-vibration coupling. [4] In the later case, we will summarize in particular our attempts to provide a description of electron-phonon coupling properties within simplified *GW* schemes.

Acknowledgements. Work done in collaboration with C. Faber, P. Boulanger, C. Attaccallite, V. Olévano, and I. Duchemin (Grenoble, France); S. Korbel, M.A.L. Marques, S. Botti (Lyon, France); D. Jacquemin (Nantes, France), D. Beljonne (Mons, Belgium), M. Coté (Montréal, Canada) and E. Runge (Ilmenau, Germany).

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