Solving quantum chemistry problems with a quantum computer is one of the most exciting applications of future quantum technologies. Current efforts are focused on finding efficient algorithms that allow the efficient simulation of chemistry problems in a digital way. In this talk, I will present a complementary approach to the problem which consists in simulating quantum chemistry problems using ultra-cold atoms. I will first show how to simulate the different parts of the Hamiltonian, and then benchmark it with simple molecules.

References

Title: Heavy, heavier, the softest - Heavy Electrons to Explore Correlated Quantum Matter.
When: 10 December, 2018, 12h30
Where: Sala de Conferencias, Módulo 00, Faculty of Sciences, UAM.
Electronic correlations are a central theme in contemporary condensed matter physics – and hold promise for new functionality in quantum materials. In this talk I will show that heavy fermion compounds are ideal model systems to explore quantum phases and fluctuations driven by correlations. The effective mass of the conduction electron in a heavy fermion metal is not only ‘heavy’, but can become heavier and heavier on driving the system towards a quantum critical point, where the mass may ultimately diverge. At this point, a critical continuum of excitations leads to exotic properties not captured by the standard theory of metals, Fermi liquid theory. The associated accumulation of entropy makes the material extremely soft to the formation of new phases, including unconventional forms of superconductivity.

Looking for Magnetism in Graphene

Title: Looking for Magnetism in Graphene.
When: Tuesday, November 20, (2018), 12:00.
Place: Department of Theoretical Condensed Matter Physics, Faculty of Sciences, Module 5, Seminar Room (5th Floor).
Speaker: Felix Yndurain, Condensed Matter Physics Department, Universidad Autónoma de Madrid, Spain.
One of the most active research topics in graphene has been the search of magnetism. In the recent past, and based on Lieb’s theorem [1], the research has been focused on point defects like vacancies or adsorbed single atoms like hydrogen or fluorine [2,3]. Very recently, the work of Prof. P. Jarillo-Herrero’s group at MIT [4] has opened the possibility of correlated states in defect’s free twisted graphene bilayers. These issues will be discussed in the talk along recent results on magnetic moments in twisted bilayers [5].

References

H. González-Herrero et al. To be published.
F. Yndurain. To be published
Title: When Light Goes Small.
When: 19 November, 2018, 12h30
Where: Sala de Conferencias, Módulo 00, Faculty of Sciences, UAM.
Speaker: Javier Aizpurúa, Center for Materials Physics San Sebastián, DIPC, Spain.
Electronic excitations and vibrations of molecules can be efficiently excited by light thanks to the action of optical resonators which improve the interaction between light and matter. Plasmonic cavities emerge as a special type of optical resonators which “make light small” giving rise to a reduction of the electromagnetic effective mode volume down to the nanoscale, as well as to a dramatic enhancement of the local near-fields. This enhanced “small light” allows for bringing molecular spectroscopy such as fluorescence or Raman scattering to extreme levels of detection and manipulation, reaching the single-molecule regime. Furthermore, atomic-scale morphological features in plasmonic cavities produce the ultimate confinement of light, setting sub-nanometric access and control of single-molecule electronic excitations and nanoscale molecular optomechanics. To describe the interaction of light and matter at this extreme level, quantum theoretical frameworks need to be developed.

Universal Natural Shapes

Title: Universal Natural Shapes.
When: Tuesday, November 13, (2018), 12:00.
Place: Department of Theoretical Condensed Matter Physics, Faculty of Sciences, Module 5, Seminar Room (5th Floor).
Speaker: Johan Gielis, University of Antwerp, The Antenna Company, Belgium.
In the natural sciences, global anisotropies or (quasi-) periodic local deviations from isotropy or Euclidean perfection in many forms that occur in nature can be effectively dealt with by applying Gielis transformations to the basic forms that show up in Euclidean geometry, e.g. circle and spiral. Since their introduction in botany in 2003, Gielis curves, surfaces and transformations have been used in various fields of science and technology, including in nanotechnology. I will focus on 1) further generalizations and Pythagorean-compact representations, 2) Applications in biology and antennas, and 3) Generalized Möbius-Listing surfaces and bodies, in the context of possible further applications in nanotechnology and nanophotonics.