Gold clusters in helium droplets

M Gatchell[1,2], L Lundberg[1], P Martini[1], F Laimer[1], M Goulart[1], L Kranabetter[1], L Tiefenthaler[1], S Albertini[1], F Zappa[1], D K Bohme[3], and P Scheier[1]

[1]*Institut für Ionenphysik und Angewandte Physik, Universität Innsbruck, Technikerstr. 25, A-6020 Innsbruck, Austria*
[2]*Department of Physics, Stockholm University, AlbaNova University Center, 106 91 Stockholm, Sweden*
[3]*Department of Chemistry, York University, Toronto, Ontario, Canada, M3J 1P3*

Gold has been known throughout history for its untarnished luster that it owes to the chemical stability of the bulk metal. Small aggregates of gold such as clusters and nanoparticles, on the other hand, are much more reactive and have attracted significant interest as, for example, catalysts in driving hydrogenation and oxidization reactions in organic chemistry.
We use superfluid helium nanodroplets [1], containing millions of atoms or more, and with an equilibrium temperature of 0.37 K, to produce and study pure and mixed clusters of gold. In these experiments, gold is evaporated using an oven and the vapor is captured by the neutral droplets. The particles are rapidly cooled to the temperature of the He droplets and condense into clusters and small nanoparticles. The droplets may then be doped further with other molecular systems that the gold is to react with. Following electron impact ionization we study the charged products (both anions and cations are possible) using mass spectrometry.
In this talk I will present recent results from our group regarding the structures and chemical reactivity of bare gold clusters [2, 3] and complexes formed with gold and molecular species such as C_{60} [4], imidazole [5], and hydrogen [6]. I will also present new developments in the selective production of nanoparticles using gold as a test case.

[1] Mauracher A *et al* 2018 *Phys. Rep.* **751** 1–90
[2] Goulart M *et al* 2018 *Phys. Chem. Chem. Phys.* **20** 9554
[3] Martini P *et al* 2018 *Int. Jour. Mass Spectrom.* **434** 136–141
[4] Goulart M *et al* 2018 *J. Phys. Chem. Lett.* **9** 2703–2706
[5] Gatchell M *et al* 2018 *Phys. Chem. Chem. Phys.* **20** 7739
[6] Lundberg L *et al* 2019 *J. Am. Soc. Mass Spectrom.* in press