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Seminar H2020 MSCA RISE « ULTIMATE-i » :

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Chiral Induced Spin Selectivity (CISS): Unraveling the Theoretical Underpinnings and Implications in Molecular Electronics and Spintronics

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Chiral-induced Spin Selectivity or CISS has been a term used to encompass a variety of compelling experiments on molecules with either point or helical chirality (or a combination), amino acids, B-DNA, oligopeptides, Photosystem I, Alpha helices, helicene among many others that appear to be strikingly efficient in polarizing electron spin. Spin Polarization is measured in three emblematic configurations: i) Electron beam through a gas phase of point chiral molecules, ii) Photo-electrons through self-assembled monolayers, iii) Two terminal transport measurements producing spin accumulation on a metallic terminal/spin-dependent changes in the resistance in a molecular circuit. We will review the theory attempting to describe the spin-polarization and provide evidence for CISS as a stand-alone effect of chiral molecules whose spin active ingredient is the spin-orbit interaction (due to a source of inversion asymmetry such as chirality) and for two terminal setups, requires a source of time-reversal symmetry-breaking. Further, tunneling in two terminal setups exponentially enhances spin polarization to the experiments' orders.

Ernesto Medina Dagger got his PhD at MIT in 1991. He was a researcher at INTEVEP (Venezuelan Oil Industry) 1991–1997, IVIC (Venezuelan Premier Research Institute) 1997–2016, and Professor at UCV 1991–2014. In 2016, he joined the School of Physical Sciences and Nanotechnology at Yachay, Ecuador, where he served as Dean of the School of Physics and Engineering Nanotechnology. Then he moved to Universidad San Francisco de Quito, where he currently builds a theory/experimental molecular electronics lab. He has been a visiting professor at Rutgers University, Boston University, MIT, the Instituto de Materiales de Madrid, Lorraine University, and TU Dresden, and an adjunct professor at Arizona State University from 2018–2020. His areas of recent interest include molecular electronics and spintronics, as well as proximity effects in low-dimensional systems. He has published over 100 peer-reviewed articles with 3000 Scopus citations. He is a recipient of a Fulbright Scholarship in 2016, a member of the Latin American Academy of Science in 2018, a Fellow of the American Physical Society in 2019, and a TU Dresden Fellow in 2023.