THE GEORGE WASHINGTON UNIVERSITY
Department of Physics Colloquium

Choreography in Nature, in Newtonian Gravity (living in motion)

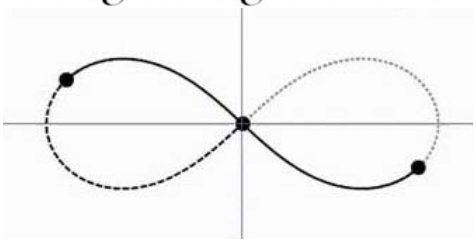
Prof. Alexander Turbiner

Universidad Nacional Autónoma de México and Stony Brook University

By definition, the choreography (dancing curve) is a close trajectory on which n classical bodies move chasing each other without collisions. The first choreography (the Remarkable Figure Eight) at zero angular momentum was discovered in physics unexpectedly by C. Moore (Santa Fe Institute) in 1993 for 3 equal masses in R^3 Newtonian gravity numerically and independently in mathematics by Chenciner(Meudon)-Montgomery(Santa Cruz) in 2000. At the moment, over 6,000 choreographies in R^3 Newtonian gravity at zero angular momentum are found, all numerically for different $n > 2$. Some number of 3-body choreographies is known for Lennard-Jones potential (hence, relevant for molecular physics) and for some other potentials, all again numerically; it might be proved their existence for quarkonia potential, thus, for classical (?) baryons.

Does there exist (non)-Newtonian gravity for which dancing curve is known analytically? Yes, a single example is known - it is algebraic lemniscate by Jacob Bernoulli (1694) - and it will be a concrete subject of the talk. Astonishingly, Newtonian Figure Eight coincides with algebraic lemniscate with χ^2 deviation of 10^{-7}. Both choreographies admit any odd numbers of bodies on each of them. 3-body choreography on lemniscate/figure eight defines maximally superintegrable trajectory with 7 constants of motion. The talk will be accompanied by numerous animations.

the figure-eight solution



$$m_k = 1,\ k = 1,2,3$$

$$L = \frac{1}{2}\sum_k \left(\frac{dq_k}{dt}\right)^2 + \sum_{i<j}\frac{1}{r_{ij}}$$

TIME: 4:00-5:00 pm, Thursday, October 24, 2019
(refreshments: 3:30 pm upstairs by the 4th floor pantry)

PLACE: 101 Corcoran Hall, GWU
725 21st Street, NW

METRO STATION: GWU/FOGGY BOTTOM (BLUE & ORANGE LINES)