STSM scientific report

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The aim of this STSM was to finalize our previously started investigations of extended theories of gravity (ETGs) and their possibility to explain different observed astrophysical phenomena, as well as to define the new investigations of the gravitational physics in the frame of ETGs. ETGs are alternative theories of gravity developed as straightforward generalizations of General Relativity (GR), assuming that the gravitational action is not only linear in the Ricci curvature scalar *R,* but can be any function *f(R).* Such gravity theories are of significance for NewCompStar since some recent studies suggested the possibility that the standard physics of neutron stars should be revised in order to obtain a realistic description of nuclear matter, its equation of state and the maximal limit of neutron star mass (see e.g. Astashenok, A. V., Capozziello, S. & Odintsov, S. D. 2015, JCAP, 1, 001). Besides, the observational data on neutron stars (mainly the mass-radius M-R relation) could be used to investigate possible deviations from GR as probe for ETGs. However, it is necessary first to obtain the reliable constrains on the parameters of ETGs.

Therefore, during the first part of the STSM, our main activities were dedicated to finalizing our previously started work on constraining the ETGs by stellar motion within the Galactic Central Parsec, and studying possible deviations of the observed orbits of S-stars from GR predictions. As a result, a new revision of our recently submitted paper: D. Borka, S. Capozziello, P. Jovanović and V. Borka Jovanović, *Probing hybrid modified gravity by stellar motion around Galactic Centre*, arXiv:1504.07832 [gr-qc] was prepared and it should be resubmitted in the following days.

An important goal of this STSM was to develop and expand collaboration between our Serbian research team (V. Borka Jovanović, D. Borka and myself) and Italian research team led by Prof. Capozziello. For that purpose and in order to introduce the Italian colleagues into my recent investigations in the field of gravitational physics, I presented a seminar at the Department of Physics of University of Naples Federico II, entitled "Gravitational lensing as a powerful tool in observational cosmology".

During the second part of the STSM, we discussed about the weak field approximations of some ETGs and at their ability to provide the fundamental base for some well known empirical relations at galactic scales, such as the fundamental plane of elliptical galaxies and the baryonic Tully-Fisher relation of spiral galaxies. Especially, we studied the possibility that the further degrees of freedom in some ETGs could give rise to the new fundamental lengths or new gravitational radii which, in the case of compact objects such as neutron stars and black holes, could play analogues roles as the Schwarzschild radius. In the case of virialized systems like galactic bulges, these new gravitational radii could provide a fundamental explanation for their observed effective radii, as well as for some empirical relations, such as M-sigma and Faber-Jackson relation. Some preliminary results in this field, obtained during this STSM, were already presented in the frame of special session dedicated

to NewCompStar during the 10th Serbian Conference on Spectral Line Shapes in Astrophysics which was held from 15 to 19 June, 2015 at Srebrno jezero, Serbia.

During the last part of the STSM, we discussed about the possibility to extend our investigations of ETGs to the strong gravity in vicinity of single and binary black holes and neutron stars, as potential sources of gravitational waves which are expected to be detected in near future by detectors like LIGO.