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NEW HOT PAPERS - 2008

July 2008

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Luca Amendola talks with *ScienceWatch.com* and answers a few questions about this month's New Hot Paper in the field of Physics.

Article Title: Conditions for the cosmological viability of f(R) dark energy models
Authors: Amendola, L;Gannouji, R;Polarski, D;Tsujikawa, S
Journal: PHYS REV D
Volume: 75
Issue: 8
Page: art.
Year: no.-083504 APR 2007
* Osserv Astron Roma, INAF, Via Frascati 33, I-00040 Monte Porzio Catone, Roma, Italy.
(addresses have been truncated)

SW: Why do you think your paper is highly cited?

Probably the reason is that this paper gives finally an exhaustive set of rules for judging whether theories that propose a form of "modified gravity" (i.e. gravity different from Einstein's Relativity theory) are acceptable or not. This is helpful because so far many scientists, at least since the 1970s, have proposed models of modified gravity and often it was not easy to ascertain whether such models were capable of explaining the current cosmological observations.

SW: Does it describe a new discovery, methodology, or synthesis of knowledge?

It's a new methodology because it shows how to understand forms of modified gravity—the so-called f (R) models—without extensive numerical and analytical analysis, simply by looking at the form of a suitable "characteristic function." This allows one to easily find the models that have the potential to explain the cosmological observations and to reject those that fail some basic criteria.

It also synthesizes previous knowledge: many of these f(R) models had been already been studied with different methods, but now we have a set of uniform criteria that can be used to classify the various cases. I think we produced a useful roadmap to gravity.

SW: Would you summarize the significance of your paper in layman's terms?

Theories of gravity that go beyond Einstein's have often been proposed to help explain puzzling features of our universe: its accelerated expansion, the large amount of invisible matter and energy, the initial states, etc. Many of these models are called f(R) theories since they generalize Einstein's gravity, which describes the space-time curvature R by introducing an arbitrary function f(R). Often however, such models, although explaining some observations, turn out to be incompatible with other features: for instance, they are inconsistent with the formation of galaxies and the cluster of galaxies.

Our paper finds a simple way to detect some of these problems and to classify in a general and compact way all f(R) models. We detail the criteria that any f(R) model have to satisfy in order to reproduce the current knowledge on the cosmic expansion. This shows at once that many models are ruled out; on the other hand, it shows how to build acceptable theories.

"Our paper finds a simple way to detect some of these problems and to classify in a general and compact way all f(R) models."

SW: How did you become involved in this research, and were there any problems along the way?

For many years I have worked on the theoretical and observational properties of gravity and modified gravity. At some point it became clear that it would have been very useful to have general criteria to evaluate models of modified gravity. We knew that some f(R) models are unacceptable and others work fine, but we did not have a simple and general way to classify these cases and understand why they were acceptable or rejected. So we started looking for such classification and ended up with the results described in our paper.

The main problem was to try to be as general as possible. We did not want to study just one or a few models: we really meant to give general criteria. It took us almost a year to realize that indeed there was a simple graphical solution to the problem.

SW: Where do you see your research leading in the future?

Gravity is the most important force at work in our universe, and the one about which we know the least. In the future, I think most cosmological research will be dedicated to a better understanding of gravity, especially at astrophysical scales, and I will continue working on this.

SW: Do you foresee any social or political implications for your research?

Not in direct way. However, understanding the large-scale geography and history of our universe is a necessary step to expand human's reach in space.

Luca Amendola
Associate Astronomer
Astronomical Observatory of Rome
Italian National Institute of Astrophysics
Rome, Italy
Observatory

Keywords: dark energy, models, theories, Einstein's gravity, modified gravity, cosmological observations, galaxies.

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