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Using SELCIE to investigate screened scalar field models sourced by complex systems.

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The mechanism that produces the dark energy driving the expansion of the universe remains a mystery. One popular proposal is to have a scalar field play the role of dark energy. Such a field would have, at least, indirect coupling to matter and so result in a new fundamental force which could be used as a probe to detect these fields. However, no such 'fifth force' has been detected so far, placing strong constraints on models of this type. The 'chameleon' is a scalar field that couples to matter but due to its nonlinear effective potential it possesses a screening mechanism which allows it to evade detection in high density regions such as our solar system, while still having a measurable effect on cosmological scales. The difficulty of this and similar models is that the nonlinear equations lack known analytic solutions except in highly symmetric cases. To this end we have developed a Python package named SELCIE (Screening Equations Linearly Constructed and Iteratively Evaluated) which allows the user to construct systems with arbitrary density profiles and solve for the resulting chameleon field profile. It accomplishes this by using the gmsh and FEniCS software packages. This software has already been used to investigate which properties of NFW halos maximise the likelihood of detecting fifth forces generated by the chameleon field. Using this tool the chameleon field profile for complex systems can be determined, allowing for new probes both from astrophysical observations and laboratory experiments.

Primary authors: Prof. MOSS, Adam (University of Nottingham); BRIDDON, Chad (University of Nottingham); Dr TAMOSIUNAS, Andrius (University of Nottingham); Prof. BURRAGE, Clare (University of Nottingham)

Presenter: BRIDDON, Chad (University of Nottingham)

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