Towards a High Sensitivity Atom Accelerometer for Exploring Physics Beyond the Standard Model

D. O. Sabulsky[1], I. J. M. Barr[1], G. Barontini[1], Y.-H. Lien[1], and E. A. Hinds[1]

[1] *Centre for Cold Matter, Blackett Laboratory, Imperial College London, Prince Consort Road, London SW7 2AZ, United Kingdom*

Presenting Author: d.sabulsky@imperial.ac.uk

Theories of dark energy usually invoke a screening mechanism to explain why their scalar fields do not produce observable long range fifth forces; a primary example of this mechanism is the so-called chameleon field. However, it is now known, from [1,2], that individual atoms are not massive enough and large enough to screen the chameleon field inside a large vacuum chamber under UHV. We present the design for an atom interferometer experiment that will place strong new constraints on the chameleon and other similar scalar fields [1].

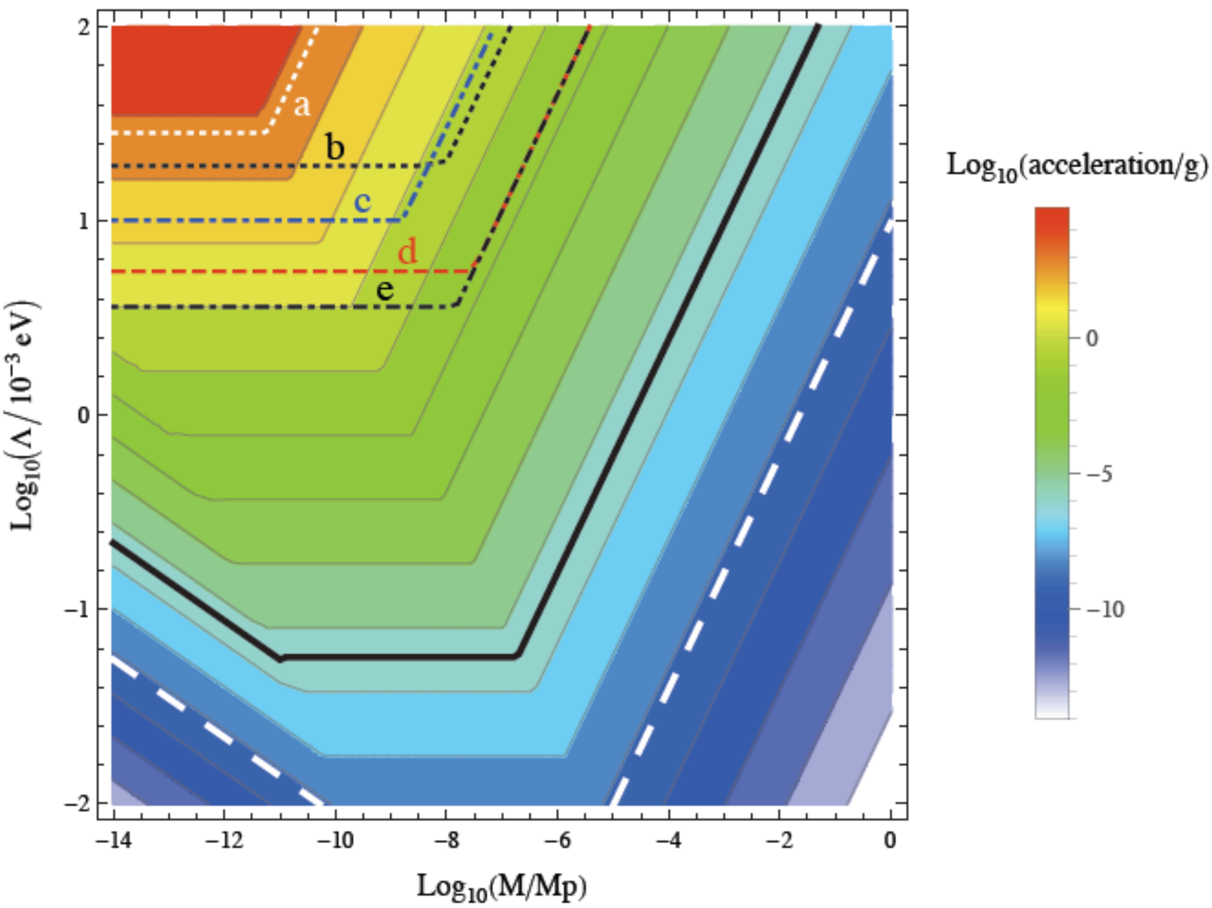

Figure 1: *Contour plot showing acceleration of rubidium atoms, normalized to the acceleration of free fall on earth g, due to the chameleon force outside a sphere of radius $R_A = 1$ cm and screening factor $\lambda_A = \frac{3M_A\phi_{bg}}{\rho_A R_A^2}$. The $L - M$ area above the heavy solid line will be excluded by a first atom interferometer experiment measuring 10^6 g. With modest attention to systematic errors, this can move down to the heavy dashed line. For $\Lambda \geq 10$ meV, atom interferometry could sense chameleon physics up to the Planck mass MP. We calculate that measurements on atoms and neutrons near surfaces, (a)-(e), already exclude the top-left corner, as indicated by the light-weight lines.*

References

[1] C. Burrage, E. J. Copeland and E. A. Hinds. arXiv: 1408.1409

[2] P. Hamilton *et al.* arXiv: 1502.03888