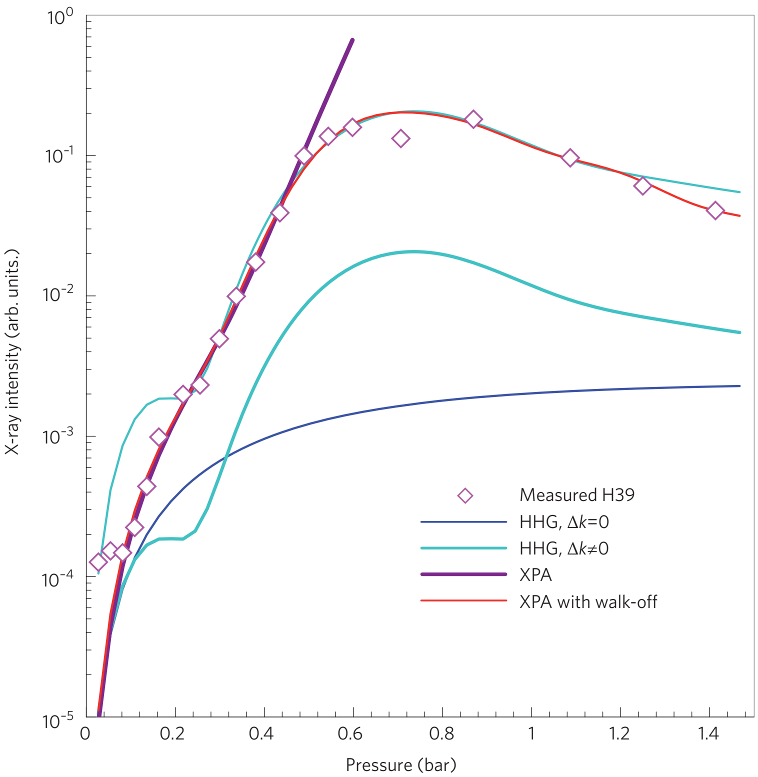

Figure 2 | Measured XUV signal at the 39th harmonic (diamonds, 2×10^{14} W cm^{-2}) as a function of the pressure in comparison with different theoretical models: pure HHG assuming $\Delta k = 0$ (dark blue) fails completely; HHG assuming a finite Δk (thin and thick light blue lines) can be fitted either to the high- or low-pressure range because it is only able to describe the evolution correctly over less than two orders of magnitude. Finally, XPA assuming a fixed gain (violet line) describes the signal evolution correctly over more than three orders of magnitude. For a perfect description in the high-pressure range (red line) too, it is necessary to include in our model a pressure-dependent gain originating from a temporal walk-off of electron and X-ray pulses, respectively.

high-pressure range we must add to our model a pressure-dependent reduction of the gain, justified by a temporal walk-off of electron and X-ray pulses, respectively. With this extension we can perfectly describe the signal evolution across the whole experimental accessible range with XPA.

A much clearer situation is given for our recent results in helium around 300 eV (ref. 1). For He, the atomic dispersion is nearly zero, the ionization rate Z and the free-electron-induced dispersion are high, and there is no re-absorption of the generated soft X-ray signal, so the absorption-limited phase-matching case, that is, super-quadratic growth, cannot exist. However, we observed the same exponential scaling of the soft X-ray signal over three orders of magnitude, in agreement with our XPA model.

Summing up, under specific experimental conditions it is possible to explain with HHG theory a super-quadratic increase of the XUV signal in a limited pressure range. However, the exponential scaling has been observed in a much wider range, and this can only be described satisfactorily by XPA. ❐

References

1. Seres, J. *et al. Nature Phys.* **6,** 455 (2010).
2. Kazamias, S. *et al. Phys. Rev. Lett.* **90,** 193901 (2003).
3. He, X. *et al. Phys. Rev. A* **79,** 063829 (2009).

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Monkey and cell-phone-user mobilities scale similarly

To the Editor — One challenge in modelling human movement is understanding recurrent patterns of space use that are not well captured by the random-walk models applied so successfully to diffusing particles. In an elegant paper, Chaoming Song *et al.*[1] showed that human mobility patterns exhibit unusual scaling laws that may be explained by a combination of random exploration and preferential return to previously visited locations.

Such recurrent movement is, however, by no means unique to humans. The patterns that Song *at al.*[1] find are in fact strongly reminiscent of what wildlife ecologists refer to as home-range behaviour[2,3]. This observation led us to repeat several of the analyses of Song *et al.* using radiotelemetry data from four capuchin monkeys foraging for fruit in the tropical forest on Barro Colorado Island, Panama[4]. Monkey mobility patterns were strikingly similar to those of urban cell-phone users, both in microscopic properties (distributions of displacement length and waiting time) and in macroscopic properties (ultraslow growth of mean squared displacement, power-law growth of the number of distinct sites visited and a power-law distribution for the number of visits per site). The power-law exponents for waiting time and rate of increase in the number of sites visited were virtually indistinguishable from those reported by Song *et al.* for humans[1].

The consistency in behaviour among monkeys in our sample and between monkeys and humans suggests that the cognitive mechanisms that control human movement are not uniquely human but have deep phylogenetic roots that transcend superficial differences in habitat and behaviour. This should stand as a warning to students of human mobility to avoid the human exceptionalism so ingrained in comparative psychology, where bold claims of human uniqueness in tool use, language, spatial memory and myriad other capacities have not survived careful scrutiny. It also implies that the expansive literature on animal home-range behaviour[2,3] is likely to hold important insights for understanding human mobility. Marrying this ecological knowledge with scaling theories from physics holds great promise for further advances in the modelling of human movement. ❐

References

1. Song, C., Koren, T., Wang, P. & Barabási, A. L. *Nature Phys.* **6,** 818–823 (2010).
2. Moorcroft, P. R. & Lewis, M. A. *Mechanistic Home Range Analysis* (Princeton Univ. Press, 2006).
3. Börger, L., Dalziel, B. D. & Fryxell, J. M. *Ecol. Lett.* **11,** 637–650 (2008).
4. Crofoot, M. C., Gilby, I. C., Wikelski, M. C. & Kays, R. W. *Proc. Natl Acad. Sci. USA* **105,** 577–581 (2008).

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