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**Non-conventional ergodic theorems, nilmanifolds, and the long term memory of dynamical systems**

There has been recent interest in time averages of dynamical parameters involving behavior at several times; e.g.,  $f(T^n(x), T^{2n}(x), T^{3n}(x))$ . It turns out that nilpotent groups play a mysterious role in this. One might summarize what's been found as the claim that the constraints on dynamical states at far apart times all have an algebraic character, and more specifically, they come from identities in nilpotent groups. I will report on the recent work on this which is due to Bernard Host and Bryna Kra.