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Sets of multiple recurrence

An integer subset set S is a set of k-recurrence if for every measure preserving system and measurable set A with positive measure, the sets $A, T^{-n}A, \dots, T^{-kn}A$ intersect on a set of positive measure for infinitely many $n \in S$. Furstenberg constructed an example of a set of 1-recurrence but not 2-recurrence. For every positive integer k we will give explicit examples of sets of k-recurrence but not $(k+1)$-recurrence (joint work with E. Lesigne and M. Wierdl). We will also discuss the question of whether the set of shifted primes is a set of k-recurrence (joint work with B. Host and B. Kra).