Ramanujan's partition congruences modulo powers of 5, 7, and 11 imply that certain sequences of partition generating functions tend p-adically to 0. Little is known about the p-adic behavior of these sequences for primes greater than 11. Using the classical theory of modular forms mod p, as developed by Serre in the 1970s, we show that these sequences are governed by "fractal" behavior. Modulo any power of any prime at least 5, these sequences of generating functions p-adically converge to linear combinations of an explicit number of finitely many special q-series. We use the general result to reveal the theory of "multiplicative partition congruences" that Atkin anticipated in the 1960s for primes from 13 to 31. This is joint work with Amanda Folsom and Ken Ono.