Additive combinatorics and higher order Fourier analysis are two active areas in the last years. In this thesis, we begin by furthering the theory of classical additive combinatorics, with a proof of a new version of the Plünnecke-Ruzsa inequality and an improvement towards the $3k-4$ conjecture in $\mathbb{Z}/p\mathbb{Z}$, applying this improvement to the study of $m$-sum-free sets. Then we introduce the theory of nilspaces and cubic couplings developed by Candela and Szegedy. A good way to approach nilspaces is to think about the relationship between groups and many problems in number theory or differential equations. Group theory was developed to isolate some important information about those problems and discard the rest. Nilspaces play the same role in certain important branches of additive combinatorics and ergodic theory. Having introduced the main ideas about nilspaces, we prove an extension of the inverse limit theorem for nilspace systems, a tool needed to extend the theorem of Host and Kra on characteristic factors of certain ergodic systems. Finally, we study a problem related to Bogolyubov’s theorem. Bilinear versions of this theorem were proved recently to deal with some problems in higher order Fourier analysis. We study an extremal case of this result which was trivial for the classical Bogolyubov’s theorem but was open in the bilinear case.