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*Non-standard methods, regularity and the completion of Hyper-graphs* (joint work with Gábor Elek)

**Abstract:** We discuss a correspondence between finite combinatorics and analysis through ultra products of direct products of finite sets. The method that we present provides a new proof for the hyper-graph regularity and removal lemmas (by Nagle-Rödl-Schacht-Skokan, Gowers, Tao) which, as it was discovered by Solymosi, imply Szemerédi's theorem on arithmetic progressions even in a multi dimensional setting. A surprising fact is that we get the removal lemma from Lebesgue's density theorem without using a counting lemma which is needed in the finite theory. We apply our method to study a certain completion of  $k$ -uniform hyper-graphs and we create limit objects for such hyper-graph sequences.