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The existence of zero-sum subgraphs in $\{-1,1\}$*-weightings of* $E(K_n)$

For a given graph H, and a $\{-1,1\}$-weighting function f of the edges of the complete graph K_n, we study the existence of a *zero-sum* copy of H; that is, a copy of H in K_n with $\sum_{e\in E(H)} f(e) = 0$. For example, for all $n \geq 5$, we can guarantee the existence of a zero-sum copy of K_4 for every $f : E(K_n) \to \{-1,1\}$ if we are provided with enough edges of both types; however, this phenomenon is not true if H is a complete graph on $m \geq 5$ vertices. So, given a graph H, our aim is to determine a function $h(H,n)$, if it exists, such that, for sufficiently large n, every $f : E(K_n) \to \{-1,1\}$ with $\min\{e(-1), e(1)\} \geq h(H,n)$ contains a zero-sum copy of H, where $e(-1)$ and $e(1)$ denote the number of edges assigned -1 and 1, respectively. In the cases where H is a path, a star or a tree, the exact function $h(H,n)$ is determined and the extremal $\{-1,1\}$-weighting functions are characterized.

Of course, such type of problems can be regarded as edge coloring problems: while Ramsey Theory studies the existence of monochromatic subgraphs in edge colorings on the complete graph, and anti-Ramsey Theory studies the existence of rainbow subgraphs, here we study the existence of *balanced* subgraphs, where balanced means to have the same number of edges of each color.

This is a joint work with Yair Caro and Adriana Hansberg.