

Thomas Zaslavsky (Binghamton)

The Circle Test for Balance of a Gain Graph

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A *gain graph* is a graph with edges orientably labelled from a group. It is *balanced* if the product of gains (the labels) around any circle is the identity (we call the circle balanced). Under set sum the circles, regarded as edge sets, generate a binary vector space, the *binary cycle space*. For which graphs Γ is it true that, whenever you have a gain graph based on Γ such that there exists a basis of the binary cycle space that is composed of balanced circles, then the gain graph is balanced? The answer is intriguing in that it is complicated but exactly solvable and it gives a special role to the group Z_3 .

This is joint work with Konstantin Rybnikov.

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