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Rational homology projective planes

A normal projective complex surface is called a rational homology projective plane (rhpp) if it has the same Betti numbers with the complex projective plane. It is known that a rhpp with quotient singularities has at most 5 singular points. So far all known examples have at most 4 singular points. In this talk, we prove that such a rhpp has at most 4 singular points except one case. The exceptional case comes from Enriques surfaces with a special configuration of 9 smooth rational curves. This answers a question posed by J. Kollár.

We also obtain a similar result in the symplectic orbifold case.

This is related to a conjecture posed by D. Montgomery and C. T. Yang in the 1970s about differentiable circle actions on the 5-dimensional sphere S^5 with finitely many non-free orbits. Some progress on this problem will also be discussed.