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Feynman Integrals, Calabi-Yau Manifolds, and Abelian Curves

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There is a surprising connection between Feyman integrals and geometry: often families of Feynman integrals are related to geometric quantities of Calabi-Yau or other manifolds. This relation makes it possible to use geometric techniques to compute the Feyman integrals, and reveals some interesting structures, both in Feynman integrals and the associated geometries. Intirguingly, it is sometimes possible to associate multiple geometries to a single Feynman integral, with each geometry providing a different point of view.

In this talk, I first give a brief overview of the connection between Feynman integrals and Calabi-Yau geometries. Then I present a novel construction of a family of Abelian curves whose periods are associated to Feynman integrals. To find such curves, we first use the connection between Feynman integrals and Calabi-Yau manifolds to express the integrals in terms of Calabi-Yau periods. Natural candidates for Abelian curves enocding these periods are then given by intermediate Jacobians, which are well-studied tori that can be associated to any Calabi-Yau manifolds. However, the classical (Griffiths and Weil) Jacobians are either Abelian or vary holomorphically, but not both, and thus do not provide a simple relation between Feynman integrals and periods. This motivates us to construct a novel type of intermediate Jacobian with both of the desirable properties. The price one has to pay is that the Jacobian is not defined everywhere in the moduli space of the Calabi-Yau manifold. However, this restriction is very natural from the amplitudes perspective: the moduli of the Calabi-Yau manifold are already restricted by conditions such as that the masses appearing in the corresponding Feynman integrals are real.

This talk is based on joint work with Jockers, Kotlewski, McLeod, Pögel, Sarve, Wang, and Weinzierl.

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