Real-normalized differentials and the geometry of the moduli space of pointed curves

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Real-normalized differentials on algebraic curves first appeared in the finite-gap approach to the theory of integrable systems. In the finite-gap approach, the coefficients of these differentials are conserved quantities of the equations of motion. Recently, real-normalized differentials have appeared in a number of problems of mathematical physics, including 2D quantum gravity, the theory of Hele-Shaw flows, and the theory of orthogonal polynomials.

I will explain how real-normalized differentials can be a useful tool for the study of the geometry of the moduli space of pointed algebraic curves. Recent results include a new proof of Diaz' theorem on complete subvarieties of M_g, a new proof of Faber's first conjecture on the tautological ring of $M_{g,n}$, and a possible solution to a problem of Eliashberg on the cohomology of certain cycles in $M_{g,n}$.

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