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Title: Maps, Hurwitz numbers and formulas for free probability at all genera

Abstract: I will talk about a transformation involving double monotone Hurwitz numbers, which has several interpretations: transformation from maps to fully simple maps, passing from cumulants to free cumulants in free probability, action of an operator in the Fock space, symplectic exchange in topological recursion. In combination with recent work of Bychkov, Dunin-Barkowski, Kazarian and Shadrin, we deduce functional relations relating the generating series of higher order cumulants and free cumulants. This solves a 15-year old problem posed by Collins, Mingo, Sniady and Speicher (the first order is Voiculescu R-transform). This leads us to a general theory of "surfaced" freeness, which captures the all order asymptotic expansions in unitary invariant random matrix models, which can be described both from the combinatorial and the analytic perspective.

Based on <https://arxiv.org/abs/2112.12184> with Severin Charbonnier, Elba Garcia-Failde, Felix Leid and Sergey Shadrin