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Fermionization of 2D anyons in a tight wave-guide

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Since free quantum particles with general statistics parameter $\alpha \in]0, 2[$ are formally equivalent to free bosons (or fermions) strongly coupled to an appropriate gauge field, it is tempting to simulate exotic statistics e.g. using cold atoms coupled to density-dependent synthetic gauge fields.

This has raised interest both in the context of 2D and 1D anyons, reviving the question of the connection between the two concepts. We ask the question of what 1D anyon model (amongst the several proposed ones), if any, is the limit of the main 2D anyon model.

We consider a many-body system of 2D anyons, described in the magnetic gauge picture as bosons attached to Aharonov-Bohm fluxes of intensity $2\pi\alpha$. A dimensional reduction to 1D is obtained by imposing a strongly anisotropic trapping potential. This freezes the motion in the direction of strong trapping, leading to 1D physics along the weak direction. We find (via a rigorous mathematical theorem) that the latter is governed to leading order by the Tonks-Girardeau model of impenetrable bosons (exactly soluble via Girardeau's Bose-Fermi mapping) independently of α.

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