Topological Phase Defects in Scalar Field Θ

Consider a vortex configuration in 2D:

$$\phi(\theta) = n\theta, \quad \rho(r) \to 0 \text{ as } r \to 0$$

Then:

$$\nabla\phi = \frac{n}{r}\hat{\theta}, \quad \nabla\rho \sim \rho'(r)\hat{r}$$

Their scalar product is zero due to orthogonality:

$$\nabla\rho \cdot \nabla\phi = 0$$

So the constraint is preserved even with a topological defect at the origin.

Author's Note

This work was developed solely by Ing. David Jaroš. Large language models (ChatGPT-4o by OpenAI and Gemini 2.5 Pro by Google) were used strictly as assistive tools for calculations, LaTeX formatting, and critical review. All core ideas, equations, theoretical constructs and conclusions are the intellectual work of the author.