Mathematical Methods of Modern Physics

Prof. Dr. Bernd Rosenow, SS 2025

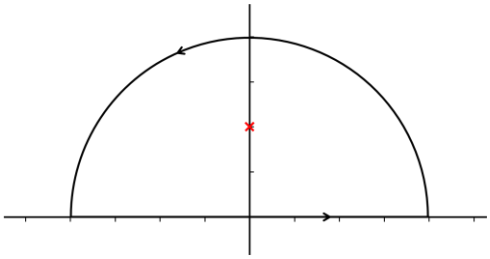
For: Bachelor: Physics (6. semester) & IPSP (6. semester), Master: Physics & IPSP & Mathematical Physics

Workload: 5 LP, 1 lecture (English) + 1 tutorial (English) per week

Exam: 1 exam (90 min), prerequisite is 50% of the points from the weekly exercise sheets

Contents:

- Complex analysis:
  - Holomorphic functions $$f'(z_0) = \left.\frac{df(z)}{dz}\right|_{z_0}$$
  - Residue theorem $$\oint_\gamma f(z)dz = 2\pi i \sum_k \Gamma(\gamma, a_k)\,\mathrm{Res}(f, a_k)$$
  - Laurent series $$f(z) = \sum_{n=-\infty}^{\infty} b_n z^n$$
  - Applications to real integrals



$$\int_{-\infty}^{\infty} \frac{1}{x^2+1}dx = 2\pi i \frac{1}{2i} = \pi$$

- Distributions and Fourier transformation

$$G^<(k,E) = \int_{-\infty}^{\infty}\int_{\infty}^{\infty} \frac{1}{2\pi}\frac{e^{-ixk}e^{iEt}}{x - vt - i\delta}dxdt = 2\pi i\delta(E - vk)\Theta(-vk)$$

- Eigenvalues and eigenfunctions