

Marko Sobak

Math PhD · C/C++ developer

Based in Vienna, AT
msobak.eu
marko.sobak1@gmail.com

Profile

- Mathematician (PhD) with 6 years of research experience in differential geometry, gauge theory, nonlinear ODE/PDE systems and numerical methods.
- Hands-on experience with C++20 (research software and personal projects) and bare-metal development in C on STM32 (HAL, CubeMX, I2C/SPI/UART, sensors and I/O devices).
- Currently developing an STM32 C driver library. Previously built a real-time C++ raytracer (60 fps on the CPU, profiled and optimised).
- Targeting C/C++ roles in sensor fusion, control, DSP, or numerical simulation, in Vienna or nearby.

Skills

Programming languages: C, C++20, Python

Embedded: STM32 HAL, CubeMX, I2C, SPI, UART, bare-metal

Tools: LaTeX, Linux, Git, CMake, GDB, OpenOCD, Perf (profiling), Catch2/Unity (unit-testing)

Mathematics: Differential geometry, Lie groups (e.g. quaternions and rotation representations), nonlinear ODE systems, mathematical physics, numerical analysis

Computer science: DSA (150+ LeetCode problems solved)

Languages: English (fluent), German (elementary), Croatian (native)

Soft: Scientific/technical writing, public presentations

Technical projects

Embedded driver library

Personal project, C, codeberg.org/msobak/EmbeddedDeviceDrivers | 2026 – ongoing

- Hardware abstraction via a single generic interface: the same driver code runs on STM32 HAL (via I2C or SPI) or against a simulation (e.g. for host-side unit testing).
- First driver: Invensense MPU-60X0 IMU (accelerometer/gyroscope), with enum-controlled configuration (power modes, filters, etc), burst reads, data-ready interrupts and unit conversion; hardware logging via UART.

Spacetime Raytracer

Personal project, C++, codeberg.org/msobak/SpacetimeRaytracer | 2026

- Real-time simulation of light-bending around black holes or wormholes using geodesic raytracing. Relativity-accurate movements of the spaceship frame modelled by a geodesic equation with forcing (acceleration and rotations). Camera rotations modelled using quaternions.
- Tensor math library and adaptive Runge-Kutta solver written from scratch; C++20 (concepts, templates); only stack-allocated memory for performance.
- Profiled and optimised to run at 60 fps at 800x800 on the CPU; cut per-frame ODE solves from $O(W \cdot H)$ to $O(\max(W, H))$ via a symmetry reduction and a lookup table.
- OpenMP parallelization; ImGui GUI; CMake build system.

Professional Experience

Postdoctoral Researcher, Mathematics

University of Vienna, Austria | 03/2024 – 09/2026

- Analysed the equations arising from the Standard Model of particle physics, resulting in several research papers.
- Developed an interactive solver in C++ for the associated coupled nonlinear ODE system. Custom math library written from scratch; ImGui / ImPlot GUI; C++20 (concepts, templates, variants); CMake build system. Link: codeberg.org/msobak/SphSymSM
- Gave multiple talks at international conferences and seminars; supervised 2 BEd students in mathematics.

Doctoral Researcher, Mathematics

University of Münster, Germany | 10/2020 – 02/2024

- Rigorously proved the existence of infinitely many solutions to a nonlinear system of ODEs, describing wormholes.
- Wrote a solver in Python (NumPy/SciPy) together with a search algorithm to find new solutions numerically. Link: codeberg.org/msobak/EinsteinYangMillsWormholes
- Taught exercise classes for BSc and MSc students in mathematics.

Education

Dr. rer. nat., Mathematics

University of Münster, Germany | 2020 – 2024

Thesis: Einstein-Yang-Mills wormholes haunted by a phantom field

M. Sc., Mathematics

Lund University, Sweden | 2018 – 2020

B. Sc., Applied Mathematics

Linnaeus University, Sweden | 2015 – 2018

Selected papers

- **M. Sobak**, *Static spherically symmetric electroweak models with fermions*, preprint (2026), [arXiv:2609.08667](https://arxiv.org/abs/2609.08667)
- **M. Sobak**, *Einstein-Yang-Mills wormholes haunted by a phantom field*, *Comm. Math. Phys.* **405**, 232 (2024), DOI: [10.1007/s00220-024-05099-z](https://doi.org/10.1007/s00220-024-05099-z)
- S. Gudmundsson, A. Siffert, **M. Sobak**, *Explicit proper p -harmonic functions on the Riemannian symmetric spaces $SU(n)/SO(n)$, $Sp(n)/U(n)$, $SO(2n)/U(n)$, $SU(2n)/Sp(n)$* , *J. Geom. Anal.* **32**, 147 (2022), DOI: [10.1007/s12220-022-00885-4](https://doi.org/10.1007/s12220-022-00885-4)

Full list available at: scholar.google.com/citations?user=MJWhx8wAAAAJ

Selected talks

- *Geometry of the Standard Model*, Masterclass Mathematical Physics, University of Vienna (2025)
- *Haunted Einstein-Yang-Mills wormholes*, Nonlinear Waves and Relativity, ESI, Vienna (2024), recording: youtube.com/watch?v=RH0LOWYBuGI