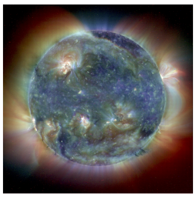
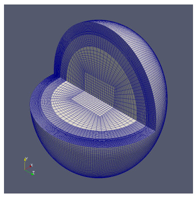




Job offer :

Scientific computing and high performance computing research engineer for computational solar physics

Expected profile

- Preferably (but not necessary) a PhD in either computer science, computional astrophysics/geophysics or applied mathematics
- Rigorous, autonomous and motivated to work in academic research within international collaboration
- Strong experience in software development for scientific computing applications (C/C++ and Fortran) and parallel programming (MPI, OpenMP)
- Good background in computional fluid dynamics (CFD) numerical methods for both incompressible and compressible fluids
- A solid experience in using CMake, git, parallel IO libraries (e.g. HDF5), continuous integration will be appreciated. Ability to understand and debug parallel software (in both shared and distributed memory environment).
- Additional qualifications : proficiency in English, ability to adapt and anticipate.

Academic context : ERC synergy project WholeSun

The WholeSun project, recently awarded an ERC synergy grant, is hiring a high-performance research engineer with a strong expertise in parallel programing for scientific application in computational solar physics. The position is located at CEA/IRFU, astrophysics department on the plateau de Saclay, near Paris in France.

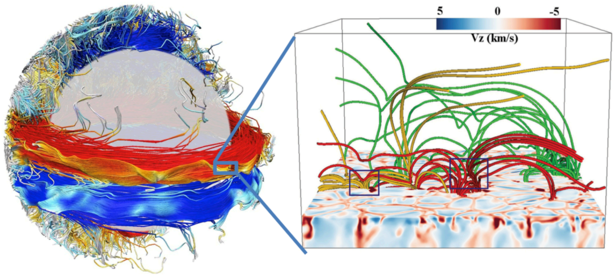
Typically, during the past few decades, solar physics research was focused towards studying the structure and dynamics of either the solar interior or of the solar surface/atmosphere. The WholeSun project's goal is to consolidate studies of these two broad solar regions by gathering several international solar physics teams, from five different countries : CEA/IRFU in France, Max-Planck-Institut for solar system research in Germany, Institutt for teoretisk astrofysikk in Norway and School of Mathematics and Statistics in UK and Instittuto de Astrofisica de Canarias in Spain. Among others, WholeSun wants to address some of the key open problems in computational solar physics today like the so called spot-dynamo paradox, i.e. the inability of most global convection dynamo models to account for sunspots creation on solar surface.

Besides fundamental physics and numerical studies on dynamo, convection, mecanisms involved in magnetic flux emergence and other surface events (eruption, flares and jets), the WholeSun project will develop a new simulation software platform for global solar studies with realistic physics, designed to harness the tremendous computing power of futur exascale supercomputers. This platform will use state of the art parallel programing model like, among others, the C++/Kokkos library for performance portability (i.e. the ability to run efficiently on all computing hardware architectures currently used in HPC) and software development productivity. The numerical methods involved to solve CFD equations include the high-order spectral difference methods, adaptive mesh refinement techniques to efficiently map the interior of the Sun as well as capture fine details at the surface of the star and its atmosphere.

Activities

- Contribute to all stages of software development including requirements, specifications, algorithms (applied mathematics, parallelism), architecture, design, implementation, testing, and physics test-case validation.
- Demonstrate your communication skills and by working closely with other software developpers as well as astrophysics.

More specifically, there will be two main activities :



- All groups involved in WholeSun have developed and are still maintaining some broadly used state-of-the-art solar physics codes (e.g. ASH, Bifrost, Muram, Mancha). The applicant will participate in developping code coupling strategies with the other's group code (based on e.g. mesh interpolation techniques, ...)
- Contribute to the development of the prototype platform [1] which provides a modern, generic, hardware architecture independant implementation of the spectral difference methods for compressible dynamics, parallelized with MPI and Kokkos for performance portability. Propose, implement and validate modifications for the spherical geometry (avoiding the poles and $r = 0$ singularities), adaptive mesh refinement, time adaptive integration, radiative transfer, dissipative physics and low Mach number flow (large time step integration). All development will be designed and driven for large scale parallelism, and multi-architecture execution.

Contact

Academic supervisors :

- A. S. Brun, head of Laboratory Dynamics of Stars, (Exo)-planets and their Environment at CEA/IRFU astrophysics departement, principal investigator of the WholeSun project.
- Pierre Kestener, HPC research engineer, CEA/Maison de la Simulation.

This position will be funded by ERC synergy grant, for up to 5 years, starting as early as possibly (from May 2019) and will be opened until filled. For more information, please send via email your curriculum vitae, name and email of two references, with `ERC WholeSUN application - research engineer` in the subject line, to allan-sacha.brun@cea.fr and pierre.kestener@cea.fr.

CEA provides a full benefit package and state-of-the-art working conditions and computing infrastructures. Wages will depend upon diploma (PhD, engineer school, etc..) and working experience. Yearly travel fund of up to 6000€ will also be available.

Keywords

Computational fluid dynamics, solar physics, high-order numerical scheme, spectral difference methods, high-performance computing, parallel programming (MPI, OpenMP), C++, Fortran, paralelism, performance portability, C++/Kokkos library.

Références

[1] Pierre Kestener and Sacha Brun. Implementing spectral difference methods (sdm) for compressible euler flow simulations using performance portable library kokkos. In *Workshop Highlights and prospects for numerical astrophysics in France, Lyon*, 2018. doi : 10.13140/RG.2.2.25985.10088. URL `http://dx.doi.org/10.13140/RG.2.2.25985.10088`.