Theory/Computation Postdoctoral Scholar in Soft Matter

The Physics and Astronomy Department at Tufts University in Medford, MA seeks a postdoctoral scholar to join a multidisciplinary NSF-funded effort to create high performance numerical methods for studying shape change in Soft Matter.

The postdoc will be working with Tim Atherton (Physics) and James Adler (Math) on a project to create an accessible open-source software package, *Morpho*, able to solve a wide variety of shape optimization, evolution and shapeshifting problems and build a community using the software for their research. Further information about the project is given below.

The primary role of the postdoc will be to apply the code to new scenarios involving shape change. An important component will be working with other research groups, both theoretical and experimental, to formulate, solve and adopt the program in their own work as well as to identify functionality required to solve new classes of problem. The postdoc will also have considerable opportunity to work independently on problems of their own within this general thematic area.

The ideal candidate will be able to demonstrate:

1. Strong prior theoretical, computational or applied mathematics work in soft matter physics or a related field.

2. Experience with programming in any language. Please note that the team will be supported by a programmer and software development expertise is not required for this role.

3. Strong communications skills, and experience in educating others, e.g. through a TA or mentoring undergraduate projects.

4. Ability to work in a team, especially across theory-experiment or disciplinary boundaries.

Tufts University is an Affirmative Action/Equal Opportunity employer and members of underrepresented groups are especially encouraged to apply.

Start Date: Preferred start date is between March 1st and June 1st 2021. This date is flexible for strong candidates who require a start date outside this range.

Please submit applications or questions about the position to mailto:Timothy.atherton@tufts.edu by January 15th 2021. Applications beyond this date will still be accepted and reviewed on a continuous basis until the position is filled. Please include a cover letter outlining how your previous experience qualifies you for the position, your CV/resumé, contact information for two references and a brief research statement.

Morpho—Cyberinfrastructure for scientists and engineers studying shape change

The goal of this project is to create an accessible open-source software package, Morpho, able to solve a wide variety of shape optimization, evolution and shapeshifting problems. These occur in numerous systems that cut across multiple NSF programs involving soft matter, an umbrella term for readily deformable materials, and includes soft robots, plastics, complex fluids, textiles, particulate media, glasses and biological materials as well as other applications in mathematics and computer science involving computational geometry. Shape change is an important feature of these systems, or a goal of the envisioned applications, but predicting their behavior is very challenging. There is presently a lack of appropriate simulation tools readily available to practitioners working in these domains inhibiting quantitative, mechanistic understanding of their behavior and optimization for applications. With Morpho, domain scientists gain a powerful new simulation tool that enables them to tackle larger and more complex shape evolution problems than presently possible. The project also creates a user community by providing extensive training opportunities including an immersive annual workshop, high quality documentation and a virtual community.

Shape optimization and evolution problems are numerically extremely challenging because the final shape is not known ahead of time: The numerical representation must be continuously monitored to ensure the solution obtained is correct and of high quality. The central innovation of Morpho is to regularize ill-posed shape problems by introducing auxiliary functionals that capture some notion of mesh quality. The aim of this work is to extend the range and complexity of problems Morpho can solve in two ways. The first is to allow the user to incorporate arbitrary types of manifolds, field quantities defined on the manifolds, discretizations, functionals and constraints pertinent to their problem. The second is to leverage multilevel algorithms and GPU computing to accelerate the simulations and enable the software to predict the dynamical response of the system given an initial configuration. The project also engages domain scientists in creating and using Morpho through a user-centered development process and a community driven science and education program, incorporating documentation, a repository of example code and tutorials, a virtual community and an annual training workshop. The resulting software and educational materials enable other researchers to simulate shape evolution in several emerging fields involving soft matter and other areas including active materials, soft robots, programmable materials and extreme mechanics.