Detailed project description for large storage application: Astrophysical turbulence and dynamo action

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1 Overview

An important astrophysics activity at Nordita focuses on the calculation of the stochastic gravitational wave (GW) background. This activity is primarily being pursued by a PhD student at Nordita and a post-doc. For those calculations we use the Pencil Code. The strengths of the resulting GW field at the present time is calculated for a range of GW sources associated with turbulent stresses in the energy-momentum tensor. This activity is supported by a VR grant on "Stochastic Gravitational Wave Background from the Early Turbulent Universe" 2019-04234, January 2020 – December 2022, 4.00 MSEK. The allocation must also partially support the activity of the rest of the Nordita group. Another activity, carried out by a new post-doc, concerns the impact of primordial magnetic fields on the formation of first luminous sources.

In all cases, the computer-generated simulation data will be stored on the PDC machine for the duration of the project. To help the initiation of new projects, a much smaller amount of data will also be stored on the PDC machines for later usage. The current usage is around 280 TB and the number of files is 48,000,000.

2 Data management plan

Computer-generated data need to be stored for later analysis and for restarting new simulations. Those are kept on temporary storage. In all cases, simulation data could be reproduced, if needed, based on the input files that, in turn, are maintained using CVS, the Concurrent Versioning System, and are published at the end of each project; see the references with DOI numbers for 15 examples of data sets published on Zenodo; see Brandenburg(2023), Brandenburg & Protiti(2023), Brandenburg et al. (2022a,b), (2023a,b,c), Carenza et al. (2022), Haugen et al. (2021), He et al. (2021,2022), Kahniashvili et al. (2022), Käpylä et al. (2022), Mizerski, et al.(2023), Roper Pol et al. (2022), Sarin et al.(2023), Sharma & Brandenburg(2022), Zhou et al. (2022). Also the Pencil Code has DOI numbers 10.5281/zenodo.2315093 and 3961647. The Pencil Code Collaboration consists of 37 coauthors on a publication to be published in the Journal of Open Source Software.

Data Format and Content We maintain records of our progress using laboratory notebooks. The notebooks document the development of new ideas and hypotheses, the records of their tests and execution, the results of data analysis and simulation, and the final results of the research. Notebooks could contain drawings, calculations, text, plots, and images. Laboratory notebooks will be legible and reasonably organized. Many ideas may be mentioned and the reasons for choices amongst alternatives will be articulated. Each laboratory notebook entry will normally be marked with the date, and sufficiently detailed and clear account of the hypotheses tried and the decisions made. Every single computer run will be done in a separate directory that is being maintained under CVS, SVN (subversion), and git (GitHub). The same applies to all secondary analysis tools that are being used for all the plots and table outputs. The computer code itself (the Pencil Code) is being maintained by GitHub (http://github.com/pencil-code), allowing every older version to be retrieved both by the researcher and members of the public.

Results of the research will be made available in digital form using formatted or unformatted data, as well as idl save files. Images will be saved in standard image formats. The main research products will be available online in digital form. Manuscripts will appear in PDF format, and will contain text, calculations, drawings, plots, and images. The targeted journals for the results of this research project, such as, The Astrophysical Journal, Phys. Rev. Letters, Phys. Rev. D and E, and Physics of Plasmas, all provide a downloadable PDF copy of the manuscript on the web. In addition, the PIs and co-PIs will link to these journal publications from their respective research websites.

Data Access and Sharing All participants in the project will publish the results of their work. Papers will primarily be published in peer-reviewed journals and/or conference proceedings. The results may also appear in books. Primary data and other supporting materials created or simulated in the course of the work will be shared with other researchers upon reasonable request and within a reasonable time of the request. In many cases, documented data sets will also be made available on the website `https://www.nordita.org/~brandenb/projects/`.

Data Archiving and Preservation of Access Products of the research will be made available immediately. Preprints of manuscripts submitted to peer-review journals will be available online through the arXiv e-print service prior to publication. After the actual publication in journals, papers will be available online from the respective journal websites and linked to by the PI's research website. All data generated as a result of this project will be backed up daily to protect from loss of data from hardware failures, fire, theft, and other unforeseen events.

3 Scientific challenges

See compute proposal.

4 Research group and management

See compute proposal.

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