The Pencil Code Newsletter

Issue 2023/3

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Figure 1: PCUM-23 in Graz: Excursion

1 Highlights

In this issue, we begin by discussing the outcome of tests to deal with the loss of the svn bridge in GitHub. We also have, for the first time, a self-presentation of most of the candidates for the next Pencil Code Steering Committee (PCSC). Next, and again for the first time, we advertise the possibility of organizing a Pencil Code User Meeting (PCUM) in 2025 and thereafter. This newsletter is decorated with pictures from the last PCUM in Graz.

2 GitHub's SVN service

GitHub is closing its subversion (SVN) service by January 8, 2024. The PCSC became active because there is a significant part of the PC community that uses SVN routinely and prefers to continue with in. The PCSC assessed all future scenarios[1] and decided that there are basically two possible options: 1) drop SVN support, disregarding the needs of a part of the community, or 2) use a new server to continue SVN & GIT support by using the SubGit.com software and mirror all changes back to GitHub.

The second solution allows the whole community to choose their versioning system – and maintain GitHub's additional services, like the list of commits and contributors, the wiki, issue tracking, commenting commits, etc. The only change for GIT users would be to change their repository URL once only from github.com to pencil-code.org with a simple command: `git remote set-url origin https://USERNAME@pencil-code.org/git/...`; see here: `https://pencil-code.org/download.php`. The GitHub repository would be always up-to-date but would become read-only.

2.1 Live SubGit testing

Members of the PCSC and the PC community have tested the SubGit setup within the "playground" repository. In two testing sessions, we performed stress tests like simultaneous commits from multiple people at the same time submitted to the SVN and the GIT side. We found that the SubGit software is a well-established and robust system that takes care of synchronizing the SVN and GIT repositories under all possible conditions and in a safe way.

Finally, all testers who participated in the testing

[1] `http://norlx65.nordita.org/~brandenb/pencil-code/PCSC/minutes/2023_11_30.txt`

phase were satisfied. Therefore, the PC community members, PC owners, and PCSC members that participated in the SubGit testing, recommend SubGit as a possible and reliable solution to continue the SVN service. All PC owners will be informed and asked to make a decision.

This decision is needed until midnight of the 19th of December. Unfortunately, on such short notice due to GitHub's hard constraint to stop their service.

2.2 User experience

As previously announced through the `pencil-code-discuss@googlegroups.com` mailing list, we tried out the new method for svn and git users during the Pencil Code office hours on December 7, 2023, and then again on December 14, 2023, Here some user experiences.

Yutong He. A few times I found myself kicked out of all branches but was put back on track with the auto-suggested commands. Conflicts could arise when multiple check-ins happen at/around the same time, and need to be manually resolved as usual. Besides these two points, switching to *playground* was straightforward for Git users.

Clara Dehman. The December 14 test focused on generating and resolving conflicts in a collaborative coding environment using svn and Git simultaneously.

Methodology:

1. Conflict generation: We initiated conflicts by pushing differing changes to the same line of code nearly simultaneously. Some modifications were pushed by Git users and some others were pushed by svn users.

2. Observations: In cases where another user's modification preceded, the system prompted a need to pull the latest changes before pushing new ones.

3. Conflict resolution: The resolution was done by fixing the conflicted file and selecting the desired version of the code. Then, the standard git push command was successful.

The test was successful in demonstrating conflict generation and resolution in a mixed svn and Git environment. Conflicts were solved as usual.

Axel Brandenburg. SVN users just need to check out a fresh copy from the new URL, as currently described in `https://pencil-code.org/download.php`, i.e., `svn co https://pencil-code.org/svn/playground/trunk playground`. Everything else was just completely normal. Conflict resolution worked as usual.

Piyali and Hongzhe successfully tested the GIT side, while Philippe tested both sides. In a final large stress-test also two more persons, Clara and Fred, committed in the same second. One after the other could finally submit their changes after updating and resolving the intentionally triggered conflicts.

2.3 GIT detached branches

When you encounter a situation where your repository appears to be on no specific branch, you can verify this by `git branch -a`. To return to the master branch, use `git checkout master`. Ensure that your modifications are accurately tracked and committed before proceeding. Once everything is in order, you can execute `git push`.

3 Steering committee election

We currently have 20 owners; more than half of them have declared themselves being available for serving on the PCSC; see `http://norlx65.nordita.org/~brandenb/pencil-code/PCSC/` for the terms of reference and the minutes of last meetings.

We have been provided with self-descriptions Many of them have provided a paragraph about themselves. of most of the eligible.

Sven Bingert. I got to know and love the Pencil Code when I did fluid mechanics simulations as a dissertation topic at the Kiepenheuer Institute for Solar Research in Freiburg. There I also got to know Wolfgang Dobler, who introduced me to the philosophy of the code. The simulation of the solar corona with its extremely effective heat conduction placed high demands on the code and led to numerous further developments. I continued to maintain the code and was active at numerous Pencil Code User Meetings. In 2014, I then moved to a scientific service and computing centre. There I am currently a supervisor in the HPC area and several international projects in the field of data management. I am currently also a deputy professor in computer science at the University

Figure 2: Warm weather in Graz.

of Göttingen. The further development and active use of the Pencil Code is still close to my heart.

Philippe Bourdin. My start with the Pencil Code (PC) was 15 years ago and I gained experience in solar physics and also on the technical side of the code due to my demands in high-performance computing. Since then, I introduced several mechanisms to let the PC scale on more CPUs. In the past 2.5 years, I served as a PCSC member and was elected as chair of the PCSC some months ago. I am very grateful for this proof of trust and would like to candidate again as PCSC member. My aim is to incorporate my technical understanding in the decision making process of the PC community, continue supporting the community as a whole, as well as being a contact person for PC users and owners. Because the task of the PCSC is to deal with possible personal conflicts, I like to emphasize that I address such conflicts calmly and professionally. I look forward to supporting the community with my experience and patience. Thank you.

Axel Brandenburg. Together with Wolfgang Dobler, we started the Pencil Code as a community project from the very beginning, before anything worked – or even compiled. Now, 22 years later, it is a pleasure to see how the code has grown to have an h-index of 37, with 37 users having done at least 37 commits (`https://github.com/pencil-code/pencil-code/graphs/contributors`). With now 20 owners, who can give check-in permissions to others, the code can stand on its own – even when the original roots get old. One of my main ambitions is to facilitate maximum freedom in the sense that *everything is allowed* – as long as it doesn't disturb anybody else. Of course, the auto-tests don't capture everything, and there are also a number of rules to prevent things going out of hand. This is why we have the PCSC, so nobody is allowed to take critical decisions alone, and bigger things are decided by the community. The PCSC reports back to the voters and users. For the next three years, if I'm elected, I will continue to encourage users to make and check in their new developments for the benefit of the whole community.

Piyali Chatterjee. I am working with the Pencil Code since 2009 and as a PCSC member since 2020. It is a pleasure to be part of the Pencil Code community and see how it has grown and stayed together. I am one of the few women developers and owners of the code across the world, especially from south Asia. I have had the opportunity to induct and train several PhD and project students from India into the Pencil Code community. We organized the Pencil Code User Meeting (`https://www.iiap.res.in/pcum2022/?q=home`) in India for the first time in May 2022, where a few lecture modules for new users were offered (available at `https://www.youtube.com/playlist?list=PL1io4hS6YJq29NUAlDkdcHvqMddSXZ8Ko`). My primary interest is in the application of computational magnetohydrodynamics to study the Sun – from the solar interior to the corona, e.g., quiet Sun phenomena like the formation of the spicule forest as well as eruptive phenomena like flares and coronal mass ejections. I incorporate new and insightful modules in the Pencil Code to make solar MHD simulations more realistic. The synthetic data from such simulations can then be forward modelled to churn out observables which are directly measured by existing space instruments like Hinode/IRIS/AIA/HMI and hopefully VELC/SUIT on board Aditya-L1, India's first space-based solar observatory at Lagrange point L1. I find that most astrophysics students in India tend to use other codes, e.g., Pluto, AMRVAC for what they claim as ease of documentation rather than efficiency. If elected for the second term, I will continue to work towards expanding the Pencil Code community in India while being abreast of the latest challenges and features of the code by virtue of being part of the PCSC.

Fred Gent. I am a Research Fellow at Aalto University in Finland (now 50%) working since April 2015

Figure 3: Fred Gent & electromagnetism.

within Maarit Korpi-Lagg's astroinformatics group and also an Assistant Professor (50%) at Nordita in Stockholm, Sweden since 1st November 2023. I have been working with the Pencil Code since 2009, when making my PhD thesis at Newcastle University UK, on supernova driven turbulence in the ISM. I have had most involvement on the revision of the interstellar module, shock handling, Python for the pencil code and working with HDF5. Most recently I have refined the Runge-Kutta-Fehlberg time step method to work with third order efficiently and quickly. I aim to work on merging the various approaches to dust and particle modelling for applications to dust processing by SNe for my work with Lars Mattsson at Nordita.

Matthias Rheinhardt. Started to dive into the Pencil Code in 2007, first as a user, but after having joined NORDITA in 2009, also as a developer. I was and still am involved in building up what we call the "test methods suite" of the code, a toolbox for measuring turbulent transport coefficients. In recent years, my focus shifted to accelerating the code by using all compute resources on an HPC cluster node, most importantly, by exploiting the Graphical Processing Units (GPUs). Many of our competitor codes have already taken this turn. Thus, we have to keep pace to avoid judgements of "being outdated". Luckily, my group "Astroinformatics" at Aalto University in Finland, led by Professor Maarit Korpi-Lagg, is located in the Computer Science Department. Hence, we continuously take huge benefit of having computer science students in our group, most notably the key developers of the `Astaroth` framework for GPU acceleration. These days, we are close to finishing the embedding of `Astaroth` into the Pencil Code, which promises to reach a node-wise speedup of $\gtrsim 10$ for the PDE integration, with all other functionality running concurrently. — I have been a member of the PCSC since it was constituted, also serving as the chair for a while. Would I be re-elected, my commitment shall aim at keeping the code amongst the leading ones, by preserving and strengthening its exceptional versatility and convenience as well as by guaranteeing optimum performance on forefront hardware.

Jennifer Schober. I am thrilled to put forth my candidacy as a committee member for the PCSC. I am a group leader at the Laboratoire d'Astrophysique, École Polytechnique Fédérale de Lausanne (EPFL), Switzerland. I started using the Pencil Code during my first postdoctoral fellowship at Nordita in 2015 and became a code owner in 2022. My main interest is MHD turbulence in different astrophysical systems, from the early Universe, to galaxy clusters, and galaxies. In particular, I use the Pencil Code to explore the characteristics of MHD dynamos, delving into their nonlinear properties and uncovering essential details. If elected, I am eager to collaborate with fellow committee members to ensure the Pencil Code remains robust, adaptable, and in harmony with the evolving needs of our community.

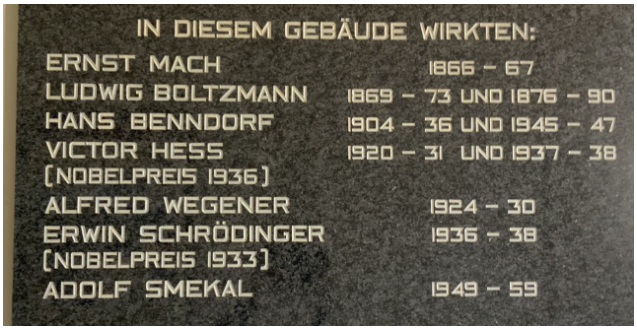

Figure 4: Standing on the shoulders of giants.

4 PCUM 2024 in Barcelona

At the last PCUM in Graz, it was decided that the next PCUM will be held at the Institute of Space Sciences (ICE, `https://www.ice.csic.es/`) in Barcelona. The

meeting will begin on Monday, September 23rd and will run through Friday, September 27.

Figure 5: The Institute of Space Sciences in Bellaterra (Barcelona).

ICE is hosting a growing community of Pencil Code users, so it is a good time to have our regular yearly meeting in this new location. This choice will likely attract more people in the institute to know something more about the code and, perhaps, to use it in their research. ICE is located on the campus of Universitat Autonoma de Barcelona, officially in the municipality of Bellaterra, which is about 50 minutes away from downtown Barcelona by metro. We will provide more details on the meeting in the next months, and in the next newsletter. Meanwhile, please mark the dates on your calendar! We hope to see many of you in Barcelona!

5 Proposals for PCUM 2025

At the last PCUM, we discussed the possibility to apply for hosting the PCUM in 2025 and thereafter. Thus, please come forward with suggestions to the editors of this newsletter. While this implies a significant amount of work, it can also be a real pleasure for those who are organizing a small meeting for the first time. If you are able to apply for additional funding, this would be great, but even without that, you can do it. The people are expected to pay their own accommodation and travel, as well as dinners and T-shirts, if the organizers design one. As before, the PCSC decides at the end of the last PCUM where the next one will be.

Figure 6: One of "our" meeting rooms at the Space Sciences in Bellaterra.

6 Reports from the last PCUM

The PCUM-23 in Graz was a great success in terms of both science dissemination and code development. In this section, we report on a few useful developments that were done during the last meeting.

Figure 7: Webcam's view during group photo in Graz.

As usual, one finds the latest code developments on `https://github.com/pencil-code/pencil-code/commits/master`. The green and red check marks indicate whether the travis test went through or not; see `https://app.travis-ci.com/github/pencil-code/pencil-code`.

6.1 Solving ODEs, coupled with PDEs

One of the important new developments concerns the code's ability to solve ODEs (time-dependent) along with PDEs – without using the full 3-D array for each variable. An example is `samples/1d-tests/axionSU2back` where we use `SPECIAL=special/axionSU2back`. Obviously, instead of doing

Figure 8: Conference dinner during PCUM-23.

```
call farray_register_pde('axi_psi',iaxi_psi)
```

for PDEs, we now do

```
call farray_register_ode('axi_Q',iaxi_Q)
```

for ODEs. Their right-hand side is here being computed in `subroutine dspecial_dt_ode`. Note, that including ODEs is currently restricted to the *special* modules as standard physics modules are not supposed to need such. Many thanks to Matthias for having devoted his expertise to this during the PCUM-23. The resulting science output can be read in Iarygina *et al.* (2023).

Figure 9: Enjoying another beer before departure. Code development in progress.

6.2 `lconcurrent`

A new switch, or at least a new name is `lconcurrent`. You may want to try out `lconcurrent=F` The code should then run somewhat slower, because it waits until all points close to the ghost zones have been communicated before calculating the rhs.

6.3 `lmodify`

Another switch is `lmodify`; it has been in the code and in the manual for 19 years, but wasn't noticed by many. It can be used to run `start.csh` without overwriting the current snapshot, but rather to modify an existing one. There are some additional things to be set, so please check the manual.

7 Papers since August 2023

As usual, we look here at new papers that make use of the Pencil Code. Since the last newsletter of August 21st, 7 new papers have appeared on the arXiv, plus 14 others, some of which were just preprints and have now been published in a journal. We list both here, 19 altogether. A browsable ADS list of all Pencil Code papers can be found on: `https://ui.adsabs.harvard.edu/public-libraries/iGR7N570Sy6AlhDMQRTe_A`. If something is missing in those entries, you can also include it yourself in: `https://github.com/pencil-code/pencil-code/blob/master/doc/citations/ref.bib`, or otherwise just email brandenb@nordita.org. A compiled version of this file is available as `https://github.com/pencil-code/website/blob/master/doc/citations.pdf`, where we also list a total of now 107 code comparison papers in the last section "Code comparison & reference". Those are not included in our list below, nor among the now total number of 699 research papers that use the Pencil Code.

References

Brandenburg, A., Kamada, K., Mukaida, K., Schmitz, K. and Schober, J., Chiral magnetohydrodynamics with zero total chirality. *Phys. Rev. D*, 2023a, **108**, 063529.

Brandenburg, A. and Protiti, N.N., Electromagnetic Conversion into Kinetic and Thermal Energies. *Entropy*, 2023, **25**, 1270.

Brandenburg, A., Sharma, R. and Vachaspati, T., Inverse cascading for initial MHD turbulence spectra between Saffman and Batchelor. *J. Plasma Phys.*, 2023b, **89**, 905890606.

Carenza, P., Sharma, R., Marsh, M.C.D., Brandenburg, A. and Ravensburg, E., Magnetohydrodynamics predicts heavy-tailed distributions of axion-photon conversion. *Phys. Rev. D*, 2023, **108**, 103029.

Elias-López, A., Del Sordo, F. and Viganò, D., Vorticity and magnetic dynamo from subsonic expansion waves. *Astron. Astrophys.*, 2023, **677**, A46.

Hidalgo, J.P., Käpylä, P.J., Ortiz-Rodríguez, C.A., Navarrete, F.H., Toro, B. and Schleicher, D.R.G., Origin of magnetism in early-type stars. *Boletin de la Asociacion Argentina de Astronomia La Plata Argentina*, 2023, **64**, 50–52.

Iarygina, O., Sfakianakis, E.I., Sharma, R. and Brandenburg, A., Backreaction of axion-SU(2) dynamics during inflation. *arXiv e-prints*, 2023, arXiv:2311.07557.

Käpylä, P.J., Convective scale and subadiabatic layers in simulations of rotating compressible convection. *arXiv e-prints*, 2023a, arXiv:2310.12855.

Käpylä, P.J., Effects of rotation and surface forcing on deep stellar convection zones. *arXiv e-prints*, 2023b, arXiv:2311.09082.

Käpylä, P.J., Browning, M.K., Brun, A.S., Guerrero, G. and Warnecke, J., Simulations of Solar and Stellar Dynamos and Their Theoretical Interpretation. *Space Sci. Ref.*, 2023, **219**, 58.

Mondal, T. and Bhat, P., Unified treatment of mean-field dynamo and angular-momentum transport in magnetorotational instability-driven turbulence. *Phys. Rev. E*, 2023, **108**, 065201.

Navarrete, F.H., Käpylä, P.J., Schleicher, D.R.G. and Banerjee, R., Effects of the centrifugal force in stellar dynamo simulations. *Astron. Astrophys.*, 2023, **678**, A9.

Ortiz-Rodríguez, C.A., Käpylä, P.J., Navarrete, F.H., Schleicher, D.R.G., Mennickent, R.E., Hidalgo, J.P. and Toro-Velásquez, B., Simulations of dynamo action in slowly rotating M dwarfs: Dependence on dimensionless parameters. *Astron. Astrophys.*, 2023, **678**, A82.

Qazi, Y., Shukurov, A., Tharakkal, D., Gent, F.A. and Bendre, A.B., Nonlinear magnetic buoyancy instability and turbulent dynamo. *arXiv e-prints*, 2023, arXiv:2310.08354.

Sankar Maity, S., Sarkar, R., Chatterjee, P. and Srivastava, N., Photospheric Lorentz force changes in eruptive and confined solar flares. *arXiv e-prints*, 2023, arXiv:2312.06787.

Sharma, R., Dahl, J., Brandenburg, A. and Hindmarsh, M., Shallow relic gravitational wave spectrum with acoustic peak. *arXiv e-prints*, 2023, arXiv:2308.12916.

Tharakkal, D., Shukurov, A., Gent, F.A., Sarson, G.R. and Snodin, A., Steady states of the Parker instability: the effects of rotation. *Month. Not. Roy. Astron. Soc.*, 2023a, **525**, 2972–2984.

Tharakkal, D., Shukurov, A., Gent, F.A., Sarson, G.R., Snodin, A.P. and Rodrigues, L.F.S., Steady states of the Parker instability. *Month. Not. Roy. Astron. Soc.*, 2023b, **525**, 5597–5613.

Väisälä, M.S., Shang, H., Galli, D., Lizano, S. and Krasnopolsky, R., Exploring the Formation of Resistive Pseudodisks with the GPU Code Astaroth. *arXiv e-prints*, 2023, arXiv:2310.16480.

Warnecke, J., Korpi-Lagg, M.J., Gent, F.A. and Rheinhardt, M., Numerical evidence for a small-scale dynamo approaching solar magnetic Prandtl numbers. *Nat. Astron.*, 2023, **7**, 662–668.

Zhou, H., Helical and non-helical large-scale dynamos in thin accretion discs. *Month. Not. Roy. Astron. Soc.*, 2024, **527**, 3018–3028.

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