The Pencil Code Newsletter

Issue 2021/2

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Contents

1 April Fool's Day issue

The previous issue of the Pencil Code newsletter appeared on April Fool's Day. Our report about a new quantum computer in Thule (Qaanaaq) in Greenland was a joke – unfortunately.

2 Pencil Code office hours

Our office hours continue to be on Fridays at 14:30 CEST. For the list of upcoming (and past) dates, see `https://www.nordita.org/~brandenb/pencil-code/office_hours/`. These events provide great opportunities for brainstorming with others about code-related issues, and also to show some new developments to others. The zoom address is `https://stockholmuniversity.zoom.us/j/6415995185`. See you then.

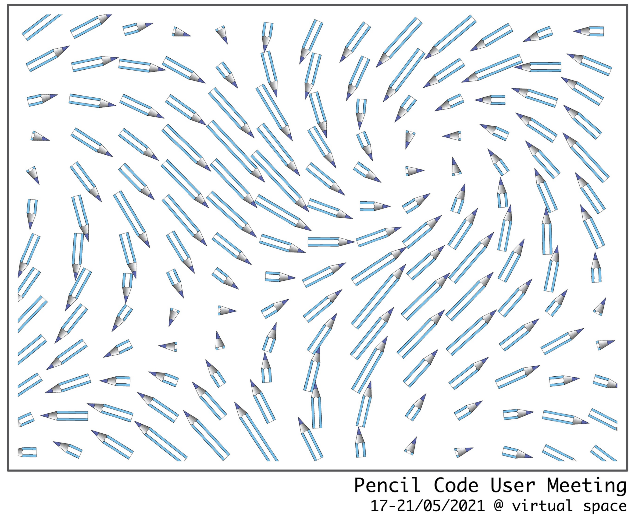

Figure 1: This year's t-shirt design (Jennifer Schober).

3 Pencil Code User Meeting

The 17th Pencil Code User Meeting took place in the week of May 17–21, 2021 and was organized by Jennifer Schober. It was a major success with many important gatherings, coding sessions, discussions, and talks; see `https://www.epfl.ch/labs/lastro/meetings/pcum2021/` for the program. Figure 1 shows this year's T-shirt design (by Jennifer Schober). Jennifer inspired us to a synchronous risotto cooking event; see Figure 2 for a screenshot of the virtual conference dinner. Figure 3 shows the conference photo.

On the EPFL website given above, you find the links to many of the presentations from the meeting. Many of them provide a useful reference for future purposes,

Figure 2: Virtual conference dinner.

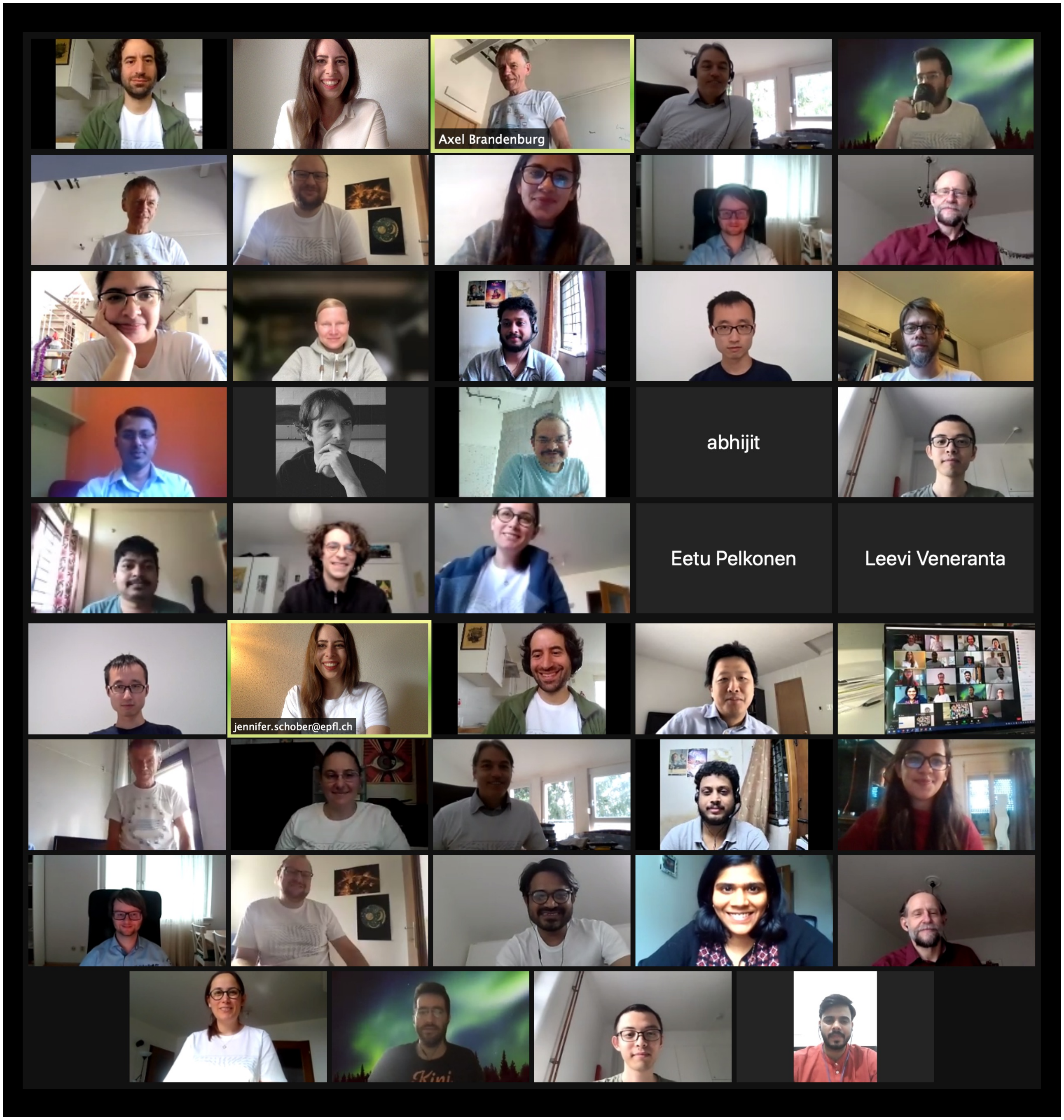

Figure 3: Group picture of the Pencil Code User Meeting 2021.

for example if you missed a talk or if something went too fast.

For the coding sessions, we had 4 different rooms where people gathered, sharing their screens, and making code changes. During May 17–21, there were 51 check-ins done by 13 different people! This also provided newcomers with the experience of seeing how new ideas make it from an initial brain storming to some trial & error phase into something that can then be checked in to the benefit of other users, who can im-

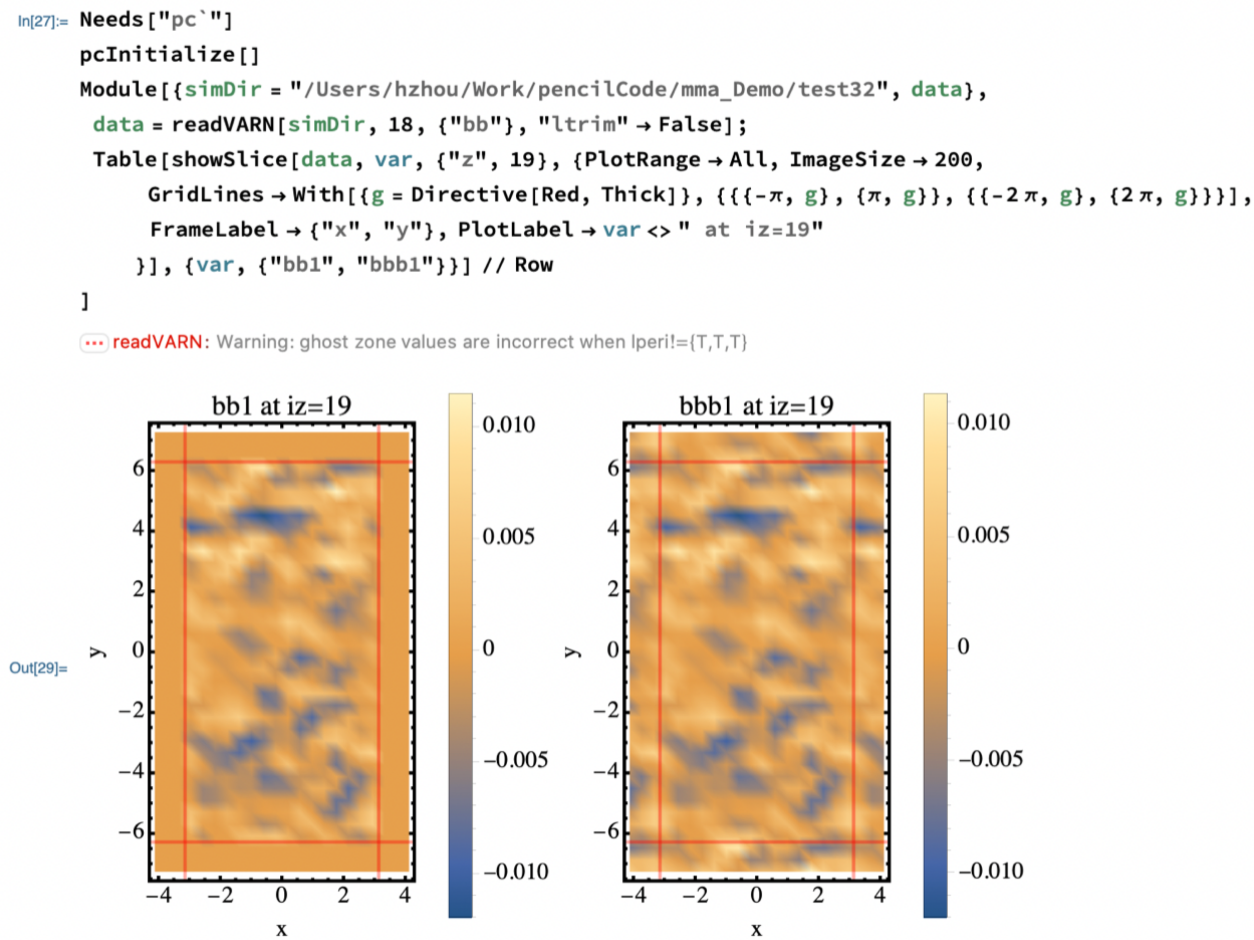

Figure 4: Comparing the written auxiliary `bb1` with `bbb1` post-processed from `aa`.

prove on it.

4 Code developments

4.1 Mathematica interface

Hongzhe Zhou from Nordita has been using Mathematica for some time to read Pencil Code data and to do post-processing. To make these routines available to the rest of the community, he has now checked them in as part of the Pencil Code. He wrote us the following text on this:

A Mathematica package for reading and post-processing data is now available. Currently some features include reading time series, power spectra, slices, VAR files, etc. Figure 4 is an illustration of reading a VAR file, computing the magnetic field from its vector potential, and then comparing with the auxiliary variable `bb` written in the VAR file. A brief introduction is at `https://github.com/pencil-code/pencil-code/tree/master/mathematica`, and more detailed tutorials will be available later. The package is still under development and everyone is welcome to contribute!

4.2 Correlation functions

During the Pencil Code User Meeting, Alberto Roper Pol started a discussion on computing correlation functions in the Pencil Code. Naveen Jingade discussed its application in shearing box simulations. Both during and after the Pencil Code User Meeting, Hongzhe Zhou from Nordita started working on the calculation of such correlation functions and sent us now the following note:

A new subroutine `powercor` is now available in

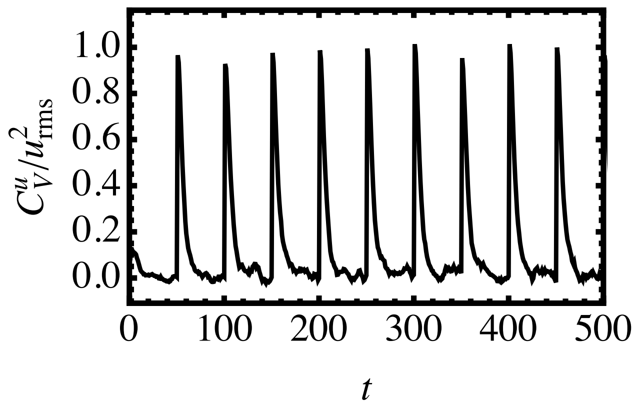

Figure 5: Box-averaged auto-correlation of the velocity field in an isotropic, nonhelically forced turbulence with $\mathtt{dtcor} = 50$.

the `power_spectrum` module, which aims to compute auto-correlation functions in both configuration and Fourier spaces. Take the velocity correlation $\int \langle \mathbf{u}(t,\mathbf{x}) \cdot \mathbf{u}(t,\mathbf{x})\rangle \, \mathrm{d}^3x$ as an example. While the second time variable t increases continuously, the first time variable t is reset to the current t every `dtcor` time. The resulting correlation function then shows peaks at $t = \mathtt{dtcor}, 2\mathtt{dtcor}, \cdots$, over which a discrete temporal average can be taken. An example plot is shown in Figure 5.

Furthermore, for shearing box simulations, a transformation to the shearing coordinates can be performed before computing correlation functions. `lvart_in_shear_frame=T` and `lshear_frame_correlation=T` are both needed.

4.3 More checks at build time

Consistency of the settings of `ncpus` and `nproc[xyz]` in `cparam.local` and of `MPICOMM` in `Makefile.local` is now checked at build time to avoid letting errors stop the code only while running. The corresponding checks within the code are preserved. Please report on undetected inconsistencies. Additional checks of the grid resolution against the processor layout will be added in the future.

4.4 Reduced numerical precision in post-processing

Our setups keep growing continually, and cases, in which full data cubes cannot anymore loaded by IDL or Python scripts due to memory restrictions accumulate. Work is ongoing to equip all scripts, reading binary data, with a keyword parameter `single`, meaning that the returned data will always have single precision (4 Byte), irrespective of what the precision of the stored data is. Particular care has to be taken to avoid that arithmetic combinations trigger a fall-back of data to double precision due to the (re-)defining property of the assignment in declaration-free languages. In Python, at a few instances a further choice, `half`, has been introduced by which the precision of the returned data is reduced to 2 Bytes. This is an extreme measure, not suited when, e.g., derivatives of the read data have to be formed. Visualization might be OK, but the outcomes should always be considered with extra care. Volunteers, helping to finish this endeavor, particularly for the Python scripts, are very welcome.

5 Changes of defaults

We should keep in mind that changes of defaults can affect an unknown number of people. One example can be a change of parameters that control the time step. During the last Pencil Code office hours, we quickly decided to reduce `cdtv` from 0.25 to 0.15, but this led to five auto tests failing and would have produced surprises to many users. It has therefore now been reverted. Evidently, for many people, the value of 0.25 was not a big problem, and people can set the value themselves in `run_pars` to whatever is right for them. The purpose of this note is to alert users to keep in mind that in some cases, the code might crash because the value 0.25 could really be too large. Please report back to others with your experience.

6 pencil-code.slack.com

As Jennifer wrote in her email of May 28, the Slack workspace generated at the Pencil Code User Meeting now continues under the new name `http://pencil-code.slack.com`. The idea is to use Slack for instant communication and quick chats rather than for official announcements and longer specific discussions. If you have not joined this year's Pencil Code User Meeting and want to become a member on Slack, please email schober.jen@gmail.com.

7 README.md

A convenient browsable entry to other web pages related to the Pencil Code is `https://github.com/pencil-code/pencil-code/blob/`

master/README.md. You can find and edit it directly on the PENCIL CODE source code page. Please help to make sure it is up-to-date.

8 Documentation

Illa R. Losada from Boulder/Colorado updated us on recent developments on code documentation and wrote us the following:

A new documentation webpage is now available for the PENCIL CODE users: https://pencil-code.readthedocs.io/en/latest/index.html. The new webpage brings together different aspects of the code documentation, with a special emphasis on the post-processing packages. Another novelty included on the webpage is the use of Sphinx to generate auto-documentation of different parts of the code. Currently, this feature is only available for the Python postprocessing package, but we are working on including Fortran and IDL.

Please, consider joining the documentation specific work group if you think about contributing and following the latest updates: https://groups.google.com/g/pencil-code-doc

9 Specialist discussion meeting on Galactic magnetic fields

Galactic magnetic fields: connecting theory, simulations, and observations. The meeting will take place on Oct. 8, 2021, between 10:00 am and 3.30 pm BST and it will be fully online. The meeting is designed to initiate a dialogue between experts from various sub-fields and to ease the comparison of work between these sub-fields (theory, simulations, observations, and experiments). More details about the meeting can be found at: https://ras.ac.uk/events-and-meetings/ras-meetings/galactic-magnetic-fields-connecting-theory-simulations-and. Registration must be done via the link on the web page (eventbrite link for non RAS fellows). The deadline for abstract submission (via the google form on the web page) for the pre-recorded talks is 15th Sept 2021. Please contact Amit Seta (amit.seta@anu.edu) and Luke Chamandy (lchamandy@pas.rochester.edu) for further questions.

10 Papers since April 2021

Since the last newsletter of April 1, 16 new papers have appeared on the arXiv, and 14 others that were just preprints, have now been published. We list both here, 30 altogether. A browsable ADS list of all PENCIL CODE papers can be found on: https://ui.adsabs.harvard.edu/user/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.

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