University of Glasgow

19 years of Pencil code

i. Scientific usage
ii. Changes & developments
iii. GAFD special issue
iv. Code & data DOIs

The 16th meeting!

27-31 Jul, 2020:	16th meeting	[agenda]	in Glasgow, Glasgow University (UK).
12-16 Aug, 2019:	15th meeting	[agenda]	in Espoo, Aalto University (Finland).
11-15 Jun, 2018:	14th meeting	[agenda]	in Boulder, University of Colorado (USA).
10-14 Jul, 2017:	13th meeting	[agenda]	in Newcastle, Newcastle University (UK).
08-12 Aug, 2016:	12th meeting	[agenda]	in Graz, Space Research Institute, Academy of Sciences (Austria).
11-15 May, 2015:	11th meeting	[agenda]	in Trondheim, Norwegian University of Science and Technology (Norway).
07-11 Jul, 2014:	10th meeting	[agenda]	in Göttingen, Max Planck Institute for Solar System Research (Germany).
17-20 Jun, 2013:	9th meeting	[agenda]	in Lund, Lund Observatory (Sweden).
18-21 Jun, 2012:	8th meeting	[agenda]	in Helsinki, Physics Department (Finland).
24-28 Oct, 2011:	7th meeting	[agenda]	in Toulouse, Observatoire Midi-Pyrénées (France).
26-30 Jul, 2010:	6th meeting	[notes]	in New York, American Museum of National History (USA).
24-28 Aug, 2009:	5th meeting	[agenda]	in Heidelberg, Max Planck Institute for Astronomy (Germany).
19-22 Aug, 2008:	4th meeting	[agenda]	in Leiden, Leiden Observatory (Netherlands).
14-17 Aug, 2007:	3rd meeting	[notes]	in Stockholm, Nordita (Sweden).
13-15 Jul, 2006:	2nd meeting	[videos]	in Copenhagen, Nordita (Denmark).
26-28 Jun, 2005:	1st meeting		in Copenhagen, Nordita (Denmark).

Historic highlights

- 2004 EoS branch
- 2007 cvs → svn
- 2008 googlecode
- 2009 first discussions on GPUs
- 2010 magnetic/meanfield
- 2013 entropy/energy module
- 2015 github

Special Issue now out

Full Article | Figures & data | References | Citations | Metrics | Reprints & Permissions | PDF

2017, **834**, 10. doi: 10.3847/1538-4357/834/1/10 [Crossref], [Web of Science ®], [Google Scholar]

46. Rogachevskii, I., Ruchayskiy, O., Boyarsky, A., Fröhlich, J., Kleeorin, N., Brandenburg, A. and Schober, J., Laminar and turbulent dynamos in chiral magnetohydrodynamics. I. Theory. *Astrophys. J.* 2017, **846**, 153. doi: 10.3847/1538-4357/aa886b [Crossref], [Web of Science ®], [Google Scholar]

47. Roper Pol, A., Brandenburg, A., Kahniashvili, T., Kosowsky, A. and Mandal, S., The timestep constraint in solving the gravitational wave equations sourced by hydromagnetic turbulence. *Geophys. Astro. Fluid* 2020, **114**, 130–161. doi:10.1080/03091929.2019.1653460. [Taylor & Francis Online], [Google Scholar]

48. Schober, J., Brandenburg, A. and Rogachevskii, I., Chiral fermion asymmetry in high-energy plasma simulations. *Geophys. Astro. Fluid* 2020, **114**, 106–129. doi:10.1080/03091929.2019.1591393. [Taylor & Francis Online], [Google Scholar]

49. Schober, J., Rogachevskii, I., Brandenburg, A., Boyarsky, A., Fröhlich, J., Ruchayskiy, O. and Kleeorin, N., Laminar and turbulent dynamos in chiral magnetohydrodynamics. II. Simulations. *Astrophys. J.* 2018, **858**, 124. doi: 10.3847/1538-4357/aaba75 [Crossref], [Web of Science ®]

People also read

Geophysical & Astrophysical Fluid Dynamics
Volume 114, 2020 - Issue 1-2
Published online: 17 Oct 2019

Article
Convergence properties of detonation simulations ›

Chengeng Qian et al.

Geophysical & Astrophysical Fluid Dynamics
Volume 114, 2020 - Issue 1-2
Published online: 25 Sep 2019

Special issue on ``Physics and Algorithms of the Pencil Code

1) Brandenburg, A., Candelaresi, S., & Gent, F. A.: 2020, ``Introduction,'' *Geophys. Astrophys. Fluid Dyn.* **114**, 1-7 (DOI:10.1080/03091

2) Käpylä, P. J., Gent, F. A., Olspert, N., Käpylä, M. J., & Brandenburg, A.: 2020, ``Sensitivity to luminosity, centrifugal force, and bound
PDF, 27 pages)

3) Aarnes, J. R., Jin, T., Mao, C., Haugen, N. E. L., Luo, K., & Andersson, H. I.: , 2020, ``Treatment of solid objects in the Pencil Code usi
DOI:10.1080/03091929.2018.1492720, PDF, 23 pages)

4) Qian, C., Wang, C., Liu, J., Brandenburg, A., Haugen, N. E. L., & Liberman, M.: 2020, ``Convergence properties of detonation simulat

5) Gent, F. A., Mac Low, M.-M., Käpylä, M. J., Sarson, G. R., & Hollins, J. F. , 2020, ``Modelling supernova driven turbulence,'' *Geophys.*

6) Schober, J., Brandenburg, A., & Rogachevskii, I.: 2020, ``Chiral fermion asymmetry in high-energy plasma simulations,'' *Geophys. Ast*

7) Roper Pol, A., Brandenburg, A., Kahniashvili, T., Kosowsky, A., & Mandal, S.: 2020, ``The timestep constraint in solving the gravitatio
DOI:10.1080/03091929.2019.1653460, PDF, 32 pages)

8) Brandenburg, A., & Das, U.: 2020, ``The time step constraint in radiation hydrodynamics,'' *Geophys. Astrophys. Fluid Dyn.* **114**, 162-

9) Singh, N. K., Raichur, H., Käpylä, M. J., Rheinhardt, M., Brandenburg, A., & Käpylä, P. J.: 2020, `` -mode strengthening from a locali
PDF, 17 pages)

10) Chatterjee, P. , 2020, ``Testing Alfven wave propagation in a realistic set-up of the solar atmosphere,'' *Geophys. Astrophys. Fluid Dyn*

11) Bourdin, P. A.: 2020, ``Driving solar coronal MHD simulations on high-performance computers,'' *Geophys. Astrophys. Fluid Dyn.* **114**

12) Warnecke, J., & Bingert, S.: 2020, *Geophys. Astrophys. Fluid Dyn.* **114**, 261-281 (arXiv:1811.01572, ADS, DOI:10.1080/03091929.201

Scientific usage of the Pencil Code

Search results using http://adslabs.org and
Bumblebee https://ui.adsabs.harvard.edu/

http://pencil-code.nordita.org/highlights/
July 2, 2020

A search using ADS https://ui.adsabs.harvard.edu/ lists the papers in which the Pencil Code is being quoted. In the following we present the papers that are making use of the code either for their own scientific work of those authors, or for code comparison purposes. We include conference proceedings, which make up 15–20% of all papers. We classify the references by year and by topic, although the topics are often overlapping. The primary application of the Pencil Code lies in astrophysics, in which case we classify the papers mostly by the field of research. Additional ap-

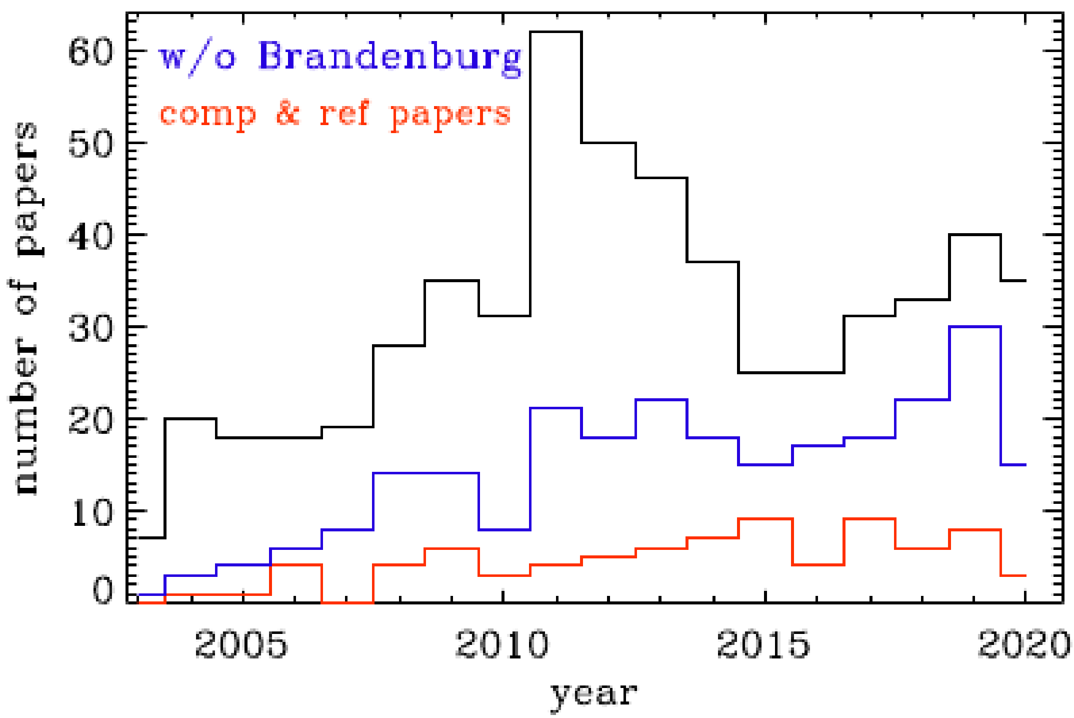


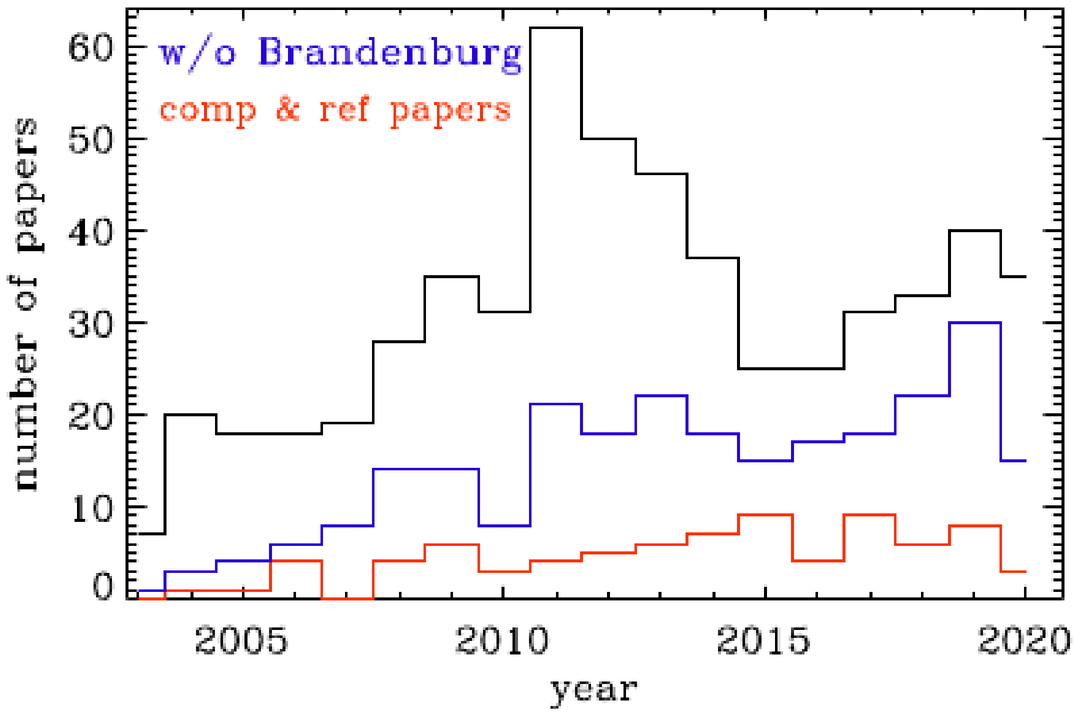
Figure 1: Number of papers since 2003 that make use of the Pencil Code. In red is shown the number of papers that reference it for code comparison or other purposes and in blue the papers that

Scientific usage of the Pencil Code

Search results using http://adslabs.org and
Bumblebee https://ui.adsabs.harvard.edu/

http://pencil-code.nordita.org/highlights/
July 2, 2020

A search using ADS https://ui.adsabs.harvard.edu/ lists the papers in which the Pencil Code is being quoted. In the following we present the papers that are making use of the code either for their own scientific work of those authors, or for code comparison purposes. We include conference proceedings, which make up 15–20% of all papers. We classify the references by year and by topic, although the topics are often overlapping. The primary applica-



As of June 2020, the Pencil Code *has been used for a total of 560 research papers; see Figure 1; 254 of those are papers (45%) are not co-authored by Brandenburg. In addition, 80 papers reference it for code comparison or other purposes (see the red line).*

The Pencil Code Newsletter

Issue 2020/1

July 17, 2020, Revision: 1.52

Contents

1 Preamble 1

2 Pencil Code User Meeting 1

3 Ongoing code developments 1

4 Manual update 2

5 Contribute to the newsletter 2

6 Not on pencil-code-discuss? 3

7 Top-ten commits: Jan–Jun 3

8 Scientific usage: updates 3

9 DOIs for simulation data 3

10 An MHD splinter meeting 4

1 Preamble

During the June 2020 meeting of the Pencil Code Steering Committee (PCSC) it was decided that the

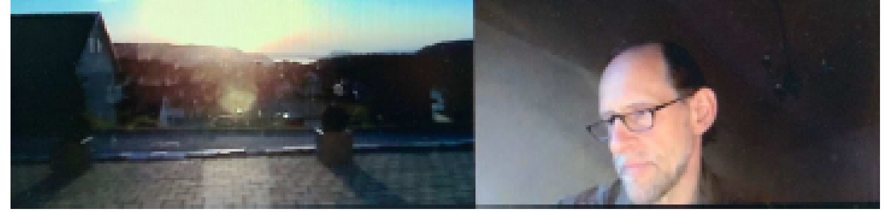


Figure 1: Axel's screenshot at the end of the PCSC meeting showing the view from Nils' window (Trondheim, Norway) and Matthias on the right on skype.

ing (PCUM) in Glasgow during 27–31 July 2020. If you forget the link, you can just say `pc_news` to get the link, which is `http://indico.fysik.su.se/event/6870/`; see Figure 2.

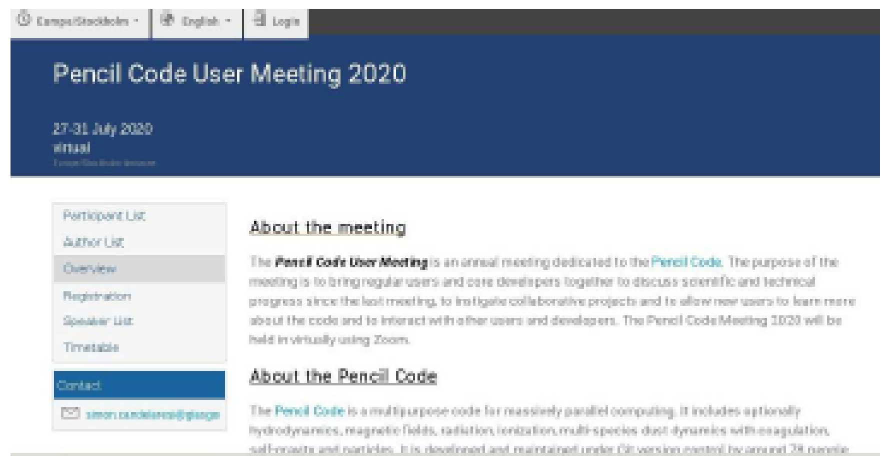


Figure 2: Web page where you can register for the meeting. Please register, even if you want to participate only in a few sessions.

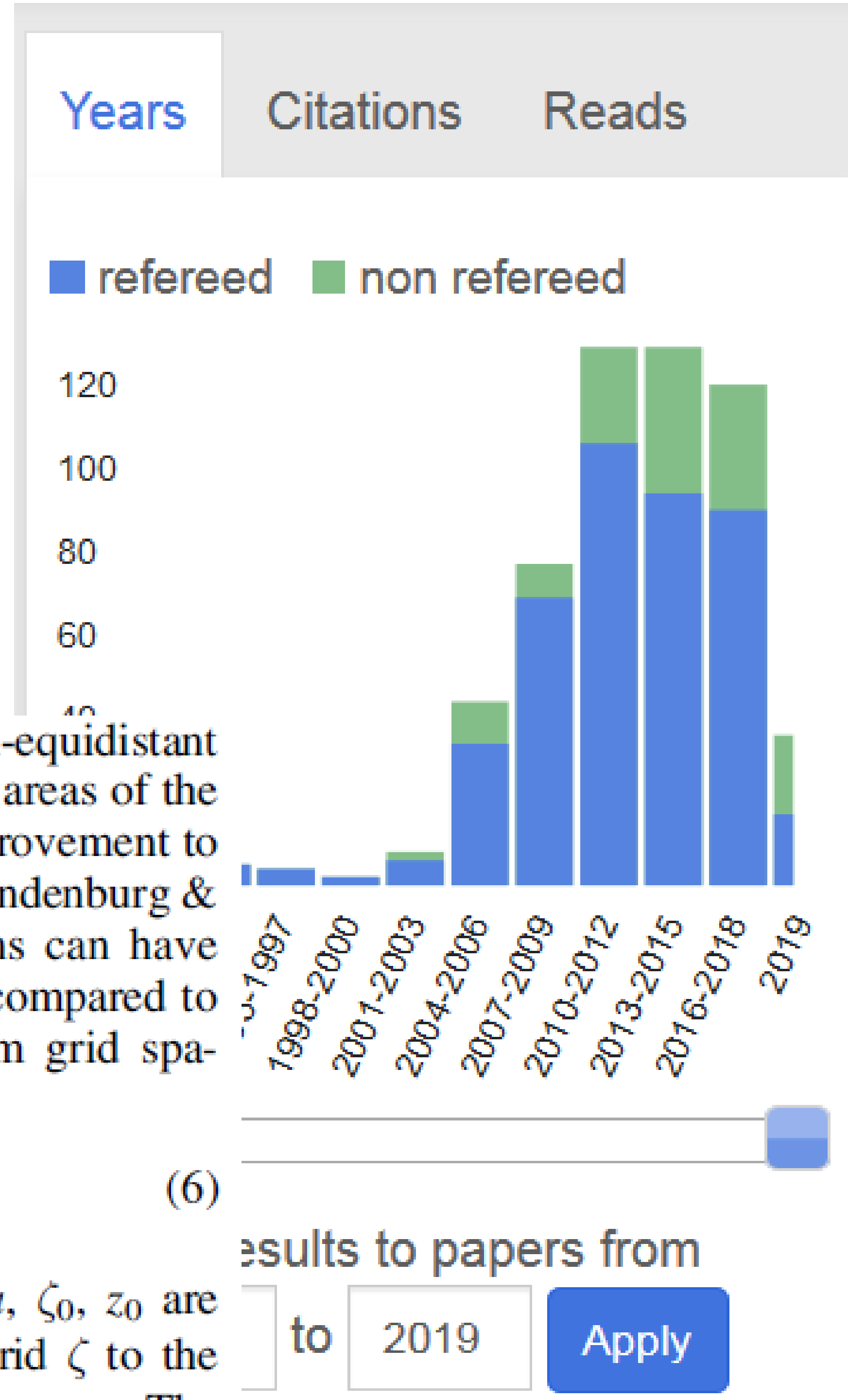
ADS: full"Pencil Code"

- Pencil Code philosophy as inspiration to others
- Here just one example

The code has also been enhanced to use non-equidistant grids to allow for increased resolution in particular areas of the Milky Way, in this case around Geminga. This improvement to GALPROP is inspired by the the Pencil Code[5] (Brandenburg & Dobler 2002), where the use of analytic functions can have advantages in terms of speed and memory usage compared to purely numerical implementations for non-uniform grid spacing. The current run uses the grid function

$$z(\zeta) = \frac{\epsilon}{a} \tan\left[a(\zeta - \zeta_0)\right] + z_0 \qquad (6)$$

for all spatial coordinates $\zeta = x, y, z$, where ϵ, a, ζ_0, z_0 are parameters. This function maps from the linear grid ζ to the



Science AAAS

www.sciencemag.org/content/364/6435/66/suppl/DC1

Supplementary Materials for

A planetesimal orbiting within the debris disc around a white dwarf star

Christopher J. Manser*, Boris T. Gänsicke, Siegfried Eggl, Mark Hollands, Paula Izquierdo, Detlev Koester, John D. Landstreet, Wladimir Lyra, Thomas R. Marsh, Farzana Meru, Alexander J. Mustill, Pablo Rodríguez-Gil, Odette Toloza, Dimitri Veras, David J. Wilson, Matthew R. Burleigh, Melvyn B. Davies, Jay Farihi, Nicola Gentile Fusillo, Domitilla de Martino, Steven G. Parsons, Andreas Quirrenbach, Roberto Raddi, Sabine Reffert, Melania Del Santo, Matthias R. Schreiber, Roberto Silvotti, Silvia Toonen†, Eva Villaver, Mark Wyatt, Siyi Xu, Simon Portegies Zwart

*Corresponding author. Email: c.j.manser92@googlemail.com

Published 5 April 2019, *Science* **364**, 66 (2019)
DOI: 10.1126/science.aat5330

led to the data collection and discussion of the results. **Competing interests:** The authors declare no conflict of interests. **Data and materials availability:** The data used in this research are available from the ESO VLT archive (36), under proposal number 595.C-0650 (G), and the GTC archive (37), under proposal numbers GTC1-16ITP and GTC25-18A. The ZEEMAN software and the model shown in fig. S5 are available from https://sourceforge.net/projects/zeeman-f/. The PENCIL CODE software is available at https://github.com/pencil-code; we used version #f4f2f16, with the model shown in figs. S6 and S7 in the directory pencil-code/samples/2d-tests/WhiteDwarfDisk.

where T_0 is the orbital period at the reference radius $r = 1R_\odot$. Sixth-order hyper-dissipation terms are added to the evolution equations to provide extra dissipation near the grid scale (94). These terms are needed for numerical stability because the high-order scheme of the PENCIL CODE (95) has little overall numerical dissipation (96). They are chosen to produce Reynolds numbers of order unity at the grid scale, but then drop as the sixth power of the scale at larger scales, so they have negligible influence on the large-scale flow. Shock diffusion is added to the equations of motion, to resolve shocks to a differentiable length (97, 98, 99). Extra Laplacian viscosity is added to the equations, with $\alpha = 10^{-2}$ (85).

Unknown connections

- Well-known for helicity studies

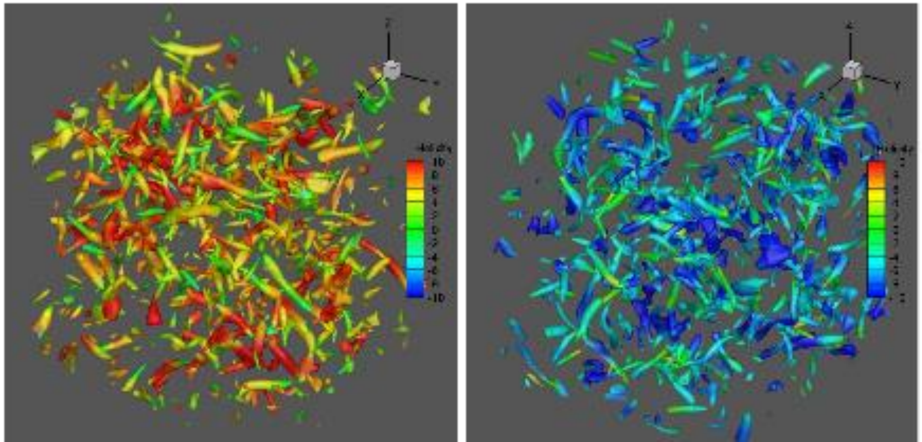
We based our helical and non-helical compressible turbulence analyses on a set of well-controlled direct numerical simulations with periodic boundary conditions. Two programs, the Pencil Code and the OpenCFD, known (the former already worldwide[15] and the latter mainly in China[16], so far) respectively in the astrophysics and aerodynamics communities, have been used for tests. Helicity controlling techniques, with or without helicity injection, say, have been well-developed, as partly already implemented in typical incompressible and compressible turbulence simulation open-source softwares[17]. The discretization grid numbers used are up to 1024^3, and for statistical steady state statisitcs, long time integrations up to 5 large-eddy turnover times were performed. Such typical 'massive' simulations resolve reasonably well into the details of flow structures, with visibly separated energy-containing, inertial, bottleneck and dissipation regimes in the power

LETTER

Helicity hardens the gas

Jun Peng[1,2,*], Jin-Xiu Xu[3], Yan Yang[1,2,*] & Jian-Zhou Zhu[2]

A screw generally works better than a nail, or a complicated rope knot better than a simple one, in fastening solid matter, while a gas is more tameless. However, a flow itself has a physical quantity, helicity, measuring the screwing strength of the velocity field and the degree of the knottedness of the vorticity ropes. It is shown that helicity favors the partition of energy to the vortical modes, compared to others such as the dilatation and pressure modes of turbulence; that is, helicity stiffens the flow, with nontrivial implications for aerodynamics, such as aeroacoustics, and conducting fluids, among others.



Monthly Notices
of the
ROYAL ASTRONOMICAL SOCIETY

MNRAS **479,** 3923–3935 (2018) doi:
Advance Access publication 2018 June 15

The influence of atomic alignment on absorption and emission spectroscopy

Heshou Zhang,[1,2] Huirong Yan[1,2★] and Philipp Richter[2,3]

[1] *Deutsches Elektronen-Synchrotron DESY, Platanenallee 6, D-15738 Zeuthen, Germany*
[2] *Institut für Physik und Astronomie, Universität Potsdam, Haus 28, Karl-Liebknecht-Str. 24/25, D-14476 Potsdam, Germany*
[3] *Leibniz-Institut für Astrophysik Potsdam (AIP), An der Sternwarte 16, D-14482 Potsdam, Germany*

4.3 Observations from the medium with turbulent magnetic fields

In order to address the issue of how much modulation can be induced with the line-of-sight dispersion of magnetic field, we perform synthetic observation on ISM with turbulent magnetic field from numerical simulation. A three-dimensional (3D) super-Alfvenic (M_a = 1.43) MHD data cube (512 × 512 × 16), which corresponds to a $1pc(x) \times 1pc(y) \times 0.2pc(z)$ diffuse layer of a reflection nebula, is generated by the MHD-simulation with the PENCIL code.[7] Note

[7] See https://code.google.com/archive/p/pencil-code/ for details.

ACKNOWLEDGEMENTS

We are grateful to Gesa Bertrang, Reinaldo Santos de Lima, Ruoyu Liu, and Michael Vorster for the helpful discussions. We thank the referee for valuable comments and suggestions.

REFERENCES

Armstrong J. W., Rickett B. J., Spangler S. R., 1995, ApJ, 443, 209
Asplund M., Grevesse N., Sauval A. J., Scott P., 2009, ARA&A, 47, 481
Bommier V., Sahal-Brechot S., 1978, A&A, 69, 57
Chepurnov A., Lazarian A., 2010, ApJ, 710, 853

36 papers in 2020

- Burning particles

  Zhang, H., Luo, K., Haugen, N.E.L., Mao, C. and Fan, J., Drag force for a burning particle. *Comb. Flame*, 2020, **217**, 188–199.

- Planetesimals

  Gerbig, K., Murray-Clay, R.A., Klahr, H. and Baehr, H., Requirements for Gravitational Collapse in Planetesimal Formation—The Impact of Scales Set by Kelvin-Helmholtz and Nonlinear Streaming Instability. *Astrophys. J.*, 2020, **895**, 91.

- Reconnection

  Santos-Lima, R., Guerrero, G., de Gouveia Dal Pino, E.M. and Lazarian, A., Diffusion of large-scale magnetic fields by reconnection in MHD turbulence., 2020, arXiv:2005.07775.

- Binaries

  Navarrete, F.H., Schleicher, D.R.G., Käpylä, P.J., Schober, J., Völschow, M. and Mennickent, R.E., Magnetohydrodynamical origin of eclipsing time variations in post-common-envelope binaries for solar mass secondaries. *Month. Not. Roy. Astron. Soc.*, 2020, **491**, 1043–1056.

Significance

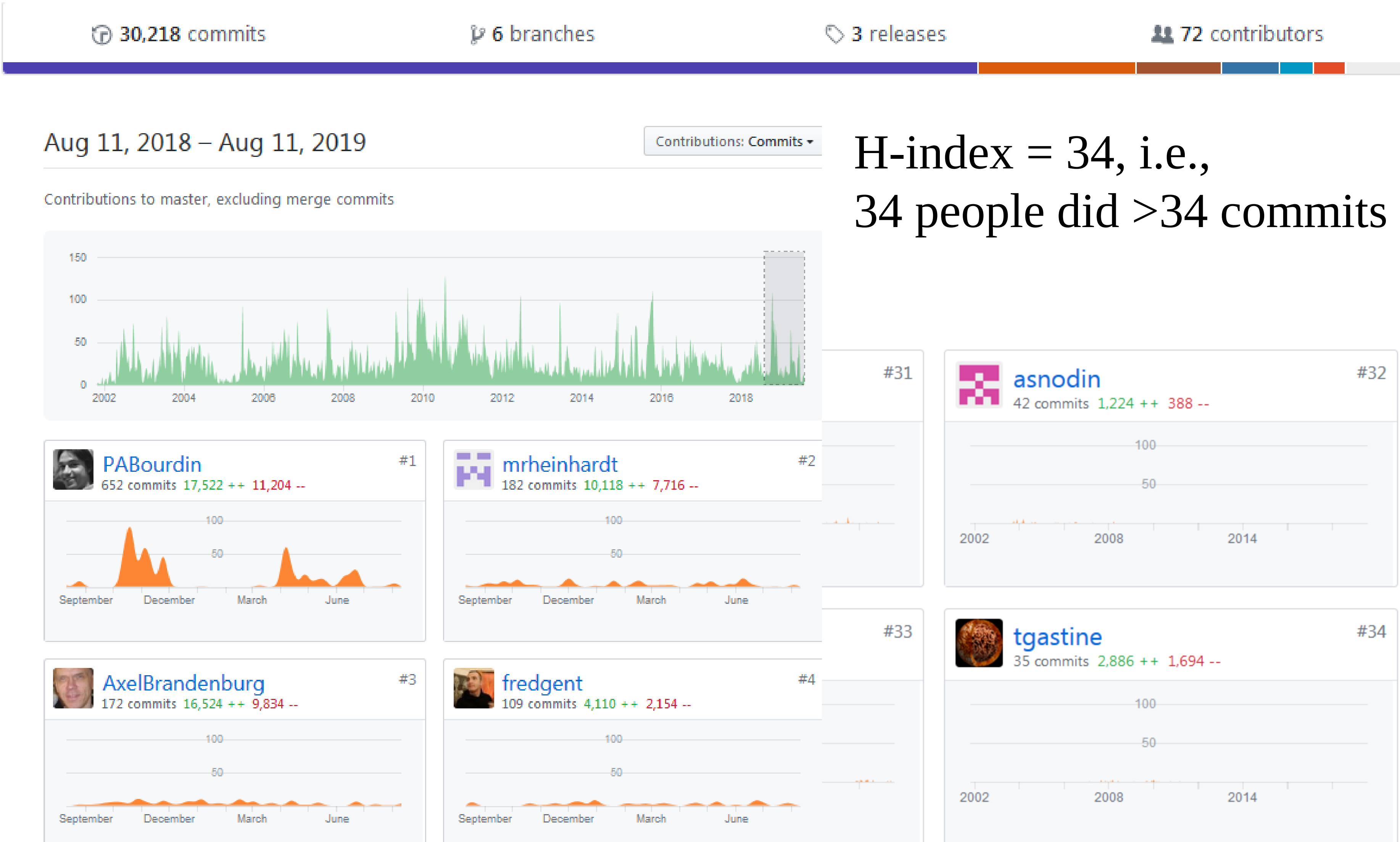
- You are not alone
  - Whatever you code, think of the others
- Backward compatibility
  - Don’t change default behavior of the code
  - Be very thoughtful if you do
- Prepare item for Newsletter about changes
  - Otherwise people would not know

Hourly auto-test nuisance

```
> Failed 2 test(s) out of 58:
>   /home/brandenb/pencil-hourly-tests/samples/2d-tests/torque_migration_noniso (results)
>   /home/brandenb/pencil-hourly-tests/samples/1d-tests/solar-atmosphere-temperature (results)
>
> CPU time (including compilation): 01:59:31u 11:00s
> Total wall-clock time:            01:32:48 = 01:15:02 + 17:44
> Maintainers of failed tests: betsyhern/gmail:com,Tobias:Heinemann/gmail:com
>
> ----------------------------------------------------------------------

> samples/1d-tests/solar-atmosphere-temperature: (21/58)
>     Compiling..             [double]            ok        00:58
>     Starting..                                  ok        00:00
>     Running..                                   ok        00:21
>     Validating results..                        not ok:
> Files reference.out.double, data/time_series.dat differ:
>   t: Row 2: 0.03518632498753 > 0.035186324982417 according to absolute accuracy 1.5e-14
>   dt: Row 2: 0.00070372994264895 > 0.00070372994242477 according to absolute accuracy 1.5e-17
>   rhom: Row 2: 60.3536689237233 > 60.3536689234091 according to absolute accuracy 1.5e-13
>   ssm: Row 2: 0.00165490801651 < 0.00165490801942 according to absolute accuracy 1.5e-14
>   TTm: Row 2: 12707.249247501 < 12707.249407939 according to absolute accuracy 1.5e-09
>   dtu: Row 2: 0.0009272173414 > 0.0009272124863 according to absolute accuracy 1.5e-13
>   dtc: Row 2: 0.4476130493487 < 0.4476130499178 according to absolute accuracy 1.5e-13
>   dtnu: Row 2: 0.8942273525523 > 0.8942273522675 according to absolute accuracy 1.5e-13
>   dtv: Row 2: 0.4476130493487 < 0.4476130499178 according to absolute accuracy 1.5e-13
> Expected:
>  --it-----------t------------------dt-------------rhom-------------ssm---------------TTm------------dtu------------dtc--------
>     0  0.000000000000E+00 7.0372361480326E-04 60.3537438290059  0.00165500041475  12712.323410383 0.0000000000000 0.4476291125930 0
>    50  3.5186324987530E-02 7.0372994264895E-04 60.3536689237233  0.00165490801651  12707.249247501 0.0009272173414 0.4476130493487 0
>   100  7.0372977349458E-02 7.0373617876624E-04 60.3535951206501  0.00165481293269  12702.255984005 0.0022520689068 0.4475972182517 0
>   150  1.0555992411012E-01 7.0374165368271E-04 60.3535303395592  0.00165471735172  12697.381882883 0.0036244857304 0.4475833189728 0
>   200  1.4074712445108E-01 7.0374633391362E-04 60.3534749705607  0.00165462315630  12692.624458649 0.0049301127494 0.4475714367499 0
> Got:
>  --it-----------t------------------dt-------------rhom-------------ssm---------------TTm------------dtu------------dtc--------
>     0  0.000000000000E+00 7.0372361480326E-04 60.3537438290059  0.00165500041475  12712.323410383 0.0000000000000 0.4476291125930 0
>    50  3.5186324982417E-02 7.0372994242477E-04 60.3536689234091  0.00165490801942  12707.249407939 0.0009272124863 0.4476130499178 0
>   100  7.0372977328093E-02 7.0373617834269E-04 60.3535951199482  0.00165481296382  12702.257756662 0.0022519727543 0.4475972193269 0
>   150  1.0555992406369E-01 7.0374165310967E-04 60.3535303384973  0.00165471746568  12697.388333527 0.0036239075774 0.4475833204276 0
>   200  1.4074712437324E-01 7.0374633323380E-04 60.3534749692109  0.00165462341390  12692.638927961 0.0049287730349 0.4475714384759 0
>     Time used:                                       01:20 = 00:58 + 00:21
```

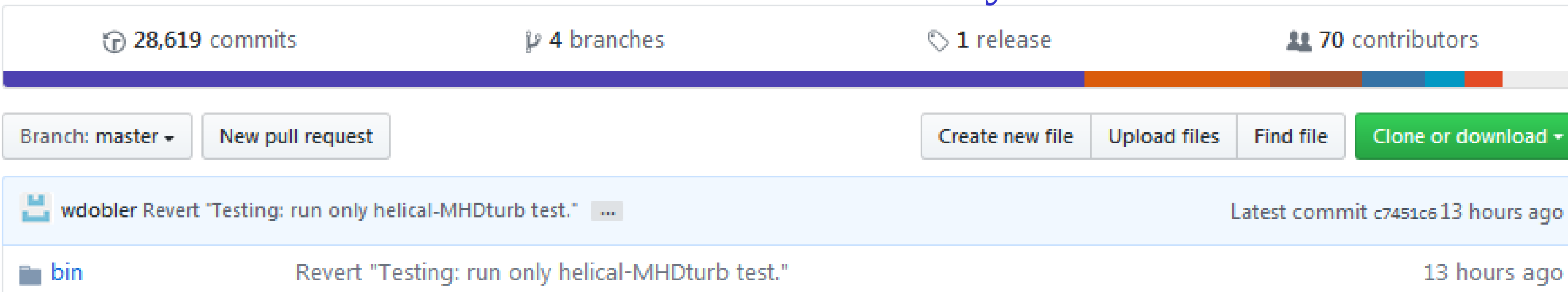
Now 30,218 commits

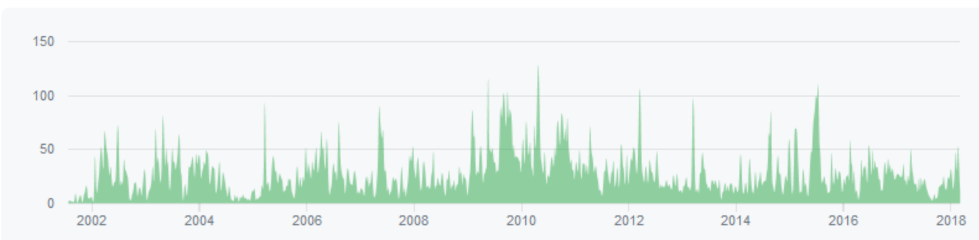


H-index = 34, i.e.,
34 people did >34 commits

Last year 28,619 commits

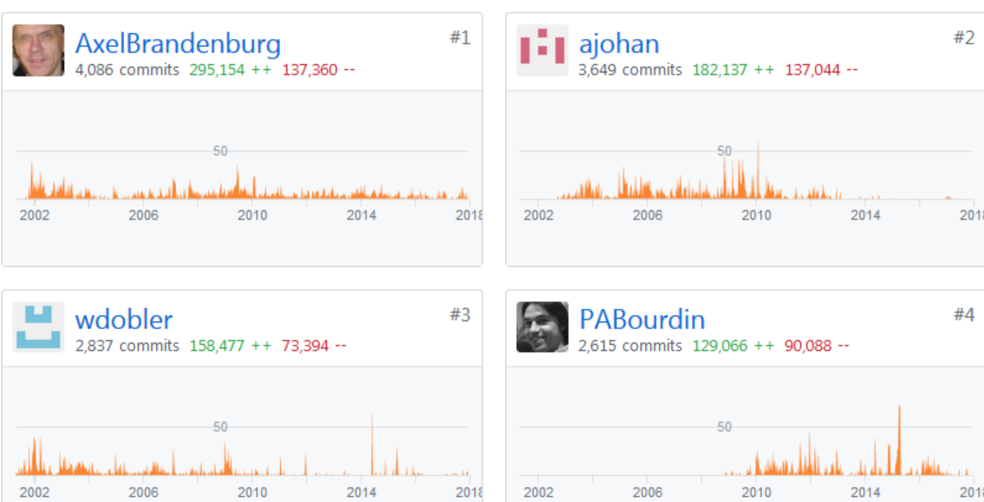
1599 more since last year

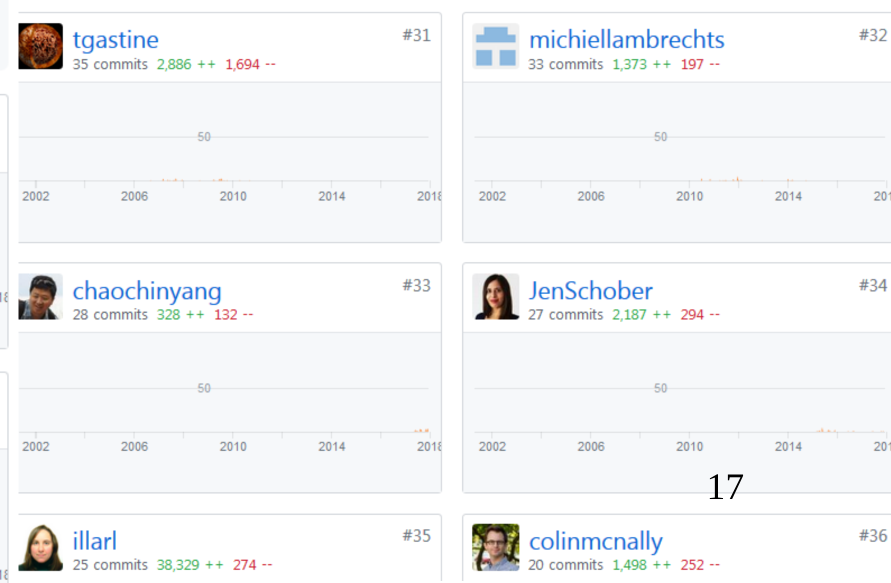




H-index = 32, i.e.,

32 people did >32 commits





Unconventional applications

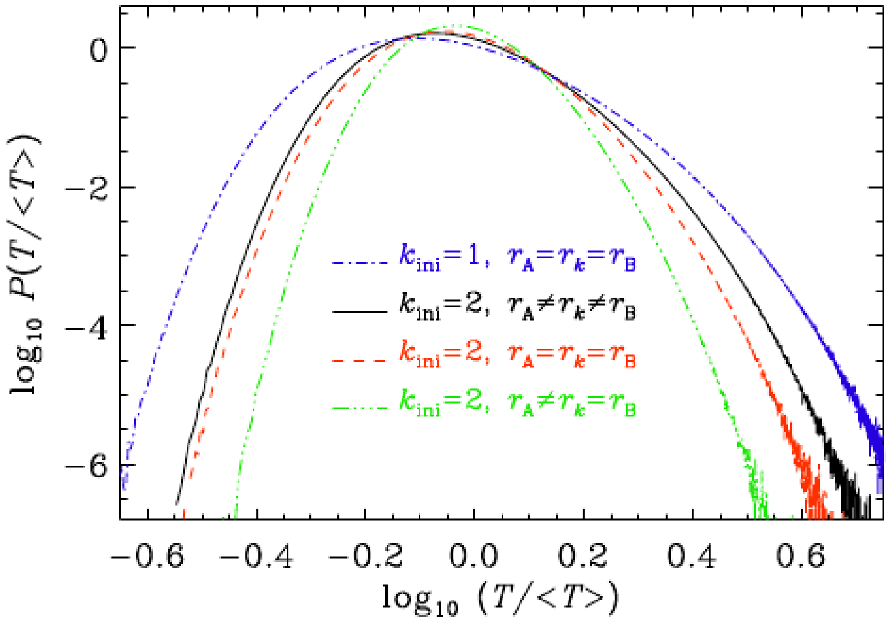


FIG. 3. Comparison of $P(T)$ in double-logarithmic representation for the LDM appropriate to our benchmark (black line) with various approximations where $r_A = r_B = r_k$ (blue for $k_{\rm ini} = 1$ and red for $k_{\rm ini} = 2$) along with a case where $k_{\rm ini} = 2$ and only $r_B = r_k$ are assumed (green lines).

TABLE 2. Moments of $X = \ln(T/\langle T\rangle)$ computed from 10^{10} realizations.

$k_{\rm ini}$	r_A	r_B	$\langle X\rangle$	$\sigma(X)$	skew X	kurt X
1	r_k	r_k	−0.062	0.35	0.32	0.00
2			−0.040	0.28	0.34	0.10
2	r_k	r_k	−0.033	0.25	0.25	0.05
2		r_k	−0.020	0.20	0.22	0.08

A straightforward extension of the LDM is to take horizontal variations in the local column density into account. Those are always present for any random initial conditions, but could be larger for turbulent systems, regardless of the particle speeds. Indeed, in our 3-D superparticle simulations, large particles can fall in different vertical columns that contain different numbers of small particles, a consequence of the fact that the small particles are initially randomly distributed. To describe the results of our 3-D simulations, it is necessary to solve for an en-

```
      intent(in) :: f,p
      intent(inout) :: df
!
      call keep_compiler_quiet(p)
!
!  identify module and boundary conditions
!
      if (headtt.or.ldebug) print*,'dspecial_dt: SOLVE dSPECIAL_dt'
!
!  Define state vector
!
      if (t==tstart) then
        tt=.0
        qq=.0
      else
        tt=f(l1:l2,m,n,ispecial)
        qq=alog(tt)
      endif
!
!  Selection of different combinations of rA and rB
!
      if (lrA.and.lrB) then
        lamk=(t**onethird+1.)**2*(t**twothird-1.)
      elseif (lrA.and..not.lrB) then
        lamk=(t**onethird+1.)**2*t**twothird
      elseif (.not.lrA.and.lrB) then
        lamk=t**twothird*(t**twothird-1.)
      else
        lamk=t**gam_lucky
      endif
!
!  Produce exponentially distributed random numbers,
!  but can also do mean-field theory as a test.
!
      if (lMFT) then
        tauk=1./lamk
      else
        call random_number_wrapper(rrr)
        tauk=-alog(rrr)/lamk
      endif
      df(l1:l2,m,n,ispecial)=df(l1:l2,m,n,ispecial)+tauk
!
!  diagnostics
!
      if (ldiagnos) then
        if (idiag_tt1m/=0) call sum_mn_name(tt    ,idiag_tt1m)
        if (idiag_qq1m/=0) call sum_mn_name(qq    ,idiag_qq1m)
        if (idiag_qq2m/=0) call sum_mn_name(qq**2,idiag_qq2m)
        if (idiag_qq3m/=0) call sum_mn_name(qq**3,idiag_qq3m)
        if (idiag_qq4m/=0) call sum_mn_name(qq**4,idiag_qq4m)
      endif
```

Unconventional

- Utilize all MPI
- IO, diagnostics, etc

```
!  -*-f90-*-  (for Emacs)    vim:set filetype=fortran:  (for vim)
!
!  cparam.local
!
!  Local settings concerning grid size and number of CPUs.
!  This file is included by cparam.f90
!
!*****************************************************************
integer, parameter :: ncpus=512,nprocx=1,nprocz=1,nprocy=ncpus/(nprocx
integer, parameter :: nxgrid=10**4,nygrid=1024*10**3,nzgrid=1
~
```

```
s Exp $'
  it1=1, isave=50000, dt=1., itorder=1
  lpencil_check_small=F
  lnspecial_pdf=F, special_pdf=T
  dsnap=1e7, dspec=1
  nt=125 !(if tstart=2)
  nt=126 !(if tstart=1)
/
&special_run_pars
  !lMFT=T
  !lrA=T, lrB=T
  !lrA=T, lrB=F
  lrA=F, lrB=F
/
&power_spectrum_run_pars
  pdf_min=0., pdf_max=20.
/
```

Run directories related to some past research projects

Isotropic homogeneous MHD turbulence

- Inverse transfer in non-helical MHD
- Classes of hydrodynamic and MHD decay
- The turbulent chiral - magnetic cascade in the early universe
- Dynamo effect in decaying helical t

Interstellar medium: cooling insta

- Thermal instability
- Random expansion waves
- Supersonic turbulence

Convection, ionization, & radiatior

- Cartesian convection with Kramers
- 1-D simulations with hydrogen ioni:
- The time step constraint in radiatic

Two-scale method of measuring magnetic helicity

- Large-scale helicity spectra

Coagulation

- Coagulation & condensation in turbulent flows
- Effect of turbulence on collisional growth of cloud droplets
- Cloud droplet growth due to supersaturation fluctuations in stratiform clouds

Miscellanea

- Spreading layer on neutron stars
- Test-field method for computing dynamo coefficients
- Strong nonlocality variations in a spherical mean-field dynamo
- Negative effective magnetic pressure instability
- Surface flux concentrations in a spherical α^2 dynamo

Other data

- Spectral magnetic helicity of solar active regions between 2006 and 2017

(last access: 16 December 2018) The DOI of the code is https://doi.org/10.5281/zenodo.2315093. The DNS setup and the corresponding data (Li et al., 2019) are freely available at https://doi.org/10.5281/zenodo.2538027.

> Thank you for submitting this manuscript, which has now been accepted
> for publication in MNRAS. This has been returned to your Author Centre
> for you to review and make any final adjustments or corrections prior
> to production and publication:
>
> Data Availability Statement
> Authors are now required to include a Data Availability Statement
> in their article. Please include this at the end of your article
> (above the references) under the heading 'Data availability'. See
> https://academic.oup.com/mnras/pages/General_Instructions#2.9%20Data%20Policy
> for more information, and for examples of Data Availability Statements.
>
> Please check that your final source files (ZIP/TAR) and manuscript
> (PDF/PS/DOC) are all present, clean (i.e. with all highlighted/bold

Code and data availability. The source code used for the simulations of this study, the Pencil Code (Brandenburg, 2018), is freely available on https://github.com/pencil-code/ (last access: 16 December 2018) The DOI of the code is https://doi.org/10.5281/zenodo.2315093. The DNS setup and the corresponding data (Li et al., 2019) are freely available at https://doi.org/10.5281/zenodo.2538027.

Our example in MNRAS (w/ Furuya)

ACKNOWLEDGEMENTS

This work was supported in part through the Swedish Research Council, grant 2019-04234, and the National Science Foundation under the grant AAG-1615100. This research is partially supported by Grants-in-Aid for Scientific Researches from the Japan Society for Promotion of Science (KAKENHI 19H0193810). We acknowledge the allocation of computing resources provided by the Swedish National Allocations Committee at the Center for Parallel Computers at the Royal Institute of Technology in Stockholm.

Code and data availability: The source code used for the simulations of this study, the PENCIL CODE (Brandenburg & Dobler 2010), is freely available on https://github.com/pencil-code/. The DOI of the code is https://doi.org/10.5281/zenodo.2315093. The simulation setup and the corresponding data are freely available on https://doi.org/10.5281/zenodo.3897954.

Data Availability Statement

The inclusion of a Data Availability Statement is a requirement for articles published in *MNRAS*. Data Availability Statements provide a standardised format for readers to understand the availability of data underlying the research results described in the article. The statement may refer to original data generated in the course of the study or to third-party data analysed in the article. The statement should describe and provide means of access, where possible, by linking to the data or providing the required unique identifier.

The Data Availability Statement should be included in the endmatter of your article under the heading 'Data availability'.

More information and example Data Availability Statements can be found under the Data Availability Statements heading.

Data Citation

MNRAS supports the Force 11 Data Citation Principles and requires that all publicly available datasets be fully referenced in the reference list with an accession number or unique identifier such as a digital object identifier (DOI). Data citations should include the minimum information recommended by DataCite: Author(s), Year, Title, Publisher (repository or archive name), Identifier

- *Example Data Citation*
  [dataset]* Zheng, J., 2019, Alice-Zheng/RSD-data: release of RSD data, Zenodo, http://doi.org/10.5281/zenodo.2538492

Where in 20 years?

- Will the code still be used?
- By others than ourselves?
- Is our samples still up to the task?
- Usage of code/data DOI
- Other thoughts?