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Article preparation guidelines

Solar Physics

P. Author-a[1] · **E. Author-b**[1] · **M. Author-c**[2]

Abstract The derivation of kinematic profiles for eruptive events is prominent in the field of solar physics. The details on the acceleration of coronal mass ejections (CMEs) and large-scale coronal disturbances ('EIT waves') are important for indicating the driving mechanisms at play. The techniques used for deriving the velocity and acceleration profiles of events based upon the height-time tracks .....

Keywords: CME, EIT Waves, Corona, Mathematical Techniques

1. Introduction

2. Numerical Differentiation Techniques

2.1. Forward/Reverse Differentiation

The forward differencing technique involves the computation of the derivative at the point $t + \Delta t$ by extrapolating forward from the point t. This uses the Taylor series:

$$r(t+\Delta t) = r(t) + r'(t)\Delta t + \frac{r''(t)}{2!}(\Delta t)^2 + \frac{r'''(t)}{3!}(\Delta t)^3 + ... \tag{1}$$

This equation can be re-arranged to give

$$r'(t)\Delta t = r(t+\Delta t) - r(t) - \frac{r''(t)}{2!}(\Delta t)^2 - \frac{r'''(t)}{3!}(\Delta t)^3 + ... \tag{2}$$

which then gives

$$r'(t) = \frac{r(t+\Delta t) - r(t)}{\Delta t} - \frac{r''(t)}{2!}(\Delta t) - \frac{r'''(t)}{3!}(\Delta t)^2 + ... \tag{3}$$

This is usually written as

$$r'(t) = v = \frac{r(t+\Delta t) - r(t)}{\Delta t} + O(\Delta t) \tag{4}$$

[1] First affiliation email: e.mail-a email: e.mail-b
[2] Second affiliation email: e.mail-c

where $O(\Delta t)$ is the truncation error term, determined by the distance between neighbouring points (Δt). This technique assumes a straight line gradient between points.

This estimate of the velocity is dependent on the initial units used for the distance. In the case of the simulation work done here, the units of distance are mega-metres (1 Mm = 10^6 m). This produces an estimate of velocity in units of Mm s^{-1}. To convert this to acceptable units of km s^{-1} requires multiplying the estimated velocity values by 10^3. This has been done in all plots showing the numerically derived velocity. Similarly, converting the acceleration from units of Mm s^{-2} requires multiplying the estimated acceleration values by 10^6.

It is possible to derive the value of the truncation error term in terms of the original $r(t)$ values. The truncation error is given as

$$O(\Delta t) = \frac{r''(t)}{2!}(\Delta t) \tag{5}$$

The $r''(t)$ term may be decomposed using the original forward-difference definition:

$$r''(t) = \frac{r'(t+\Delta t) - r'(t)}{\Delta t} \tag{6}$$

Rewriting each term using the original functional forms produces

$$O(\Delta t) = \frac{r(t+2\Delta t) - 2r(t+\Delta t) + r(t)}{2!\Delta t} \tag{7}$$

The error term associated with the velocity estimate using the forward-difference technique is therefore dependent on the value of the function $r(t)$ at the points t, $t+\Delta t$ and $t+2\Delta t$.

This equation must be modified when dealing with the error associated with the acceleration estimate. In this case, the truncation error term would be given as:

$$O(\Delta t) = \frac{v(t+2\Delta t) - 2v(t+\Delta t) + v(t)}{2!\Delta t} \tag{8}$$

Here, the velocity function $v(t)$ is treated as the base function, rather than the distance function $r(t)$ as above.

The forward-difference technique is a very simplistic technique that produces spiky plots, with large variation between points. This is a result of the inherent assumption made by the forward-difference technique that there is a straight-line gradient between points. In addition, the forward-difference technique removes a point from the end of the data-set with each differentiation due to the way it calculates the derivative.

2.2. Centre Differentiation

2.3. Lagrangian Interpolation

3. Models

3.1. const. vel.

3.2. const. accel.

3.3. non-const. accel.

3.4. Cadence

3.5. S/N

4. Data

4.1. CMEs

4.2. EIT waves

5. Bootstrapping

5.1. Using BibTeX

The use of BibTeX simplifies the inclusion of references. Only the references cited and labeled in the text are included at compilation, and an error message appears if some references are missing. Any new reference will automatically be written at the correct location in the reference list after compilation. Moreover the references are stored, in any order, in a separate file (with the `.bib` extension) in the BibTeX format, so independently of the journal format. Such a personal reference file can be re-used with any journal. The formatting of the references and their listing order are made automatically at compilation (using the information given in the `.bst` file).

The references in BibTeX format can be downloaded from the Astrophysics Data System (ADS), then stored in `SOLA_bibliography_example.bib` (file name of the present example). The main extra work is to define a proper and easy label for each citation (a convenient one is simply first-author-name-year). Furthermore, it is better to have the journal names defined by commands (for example `\solphys`), as defined at the beginning of this `.tex` file. This provides an homogeneity in the reference list and permits flexibility when changing for journals. Some caution should be taken for some journals since ADS does not necessarily provide a uniform format for the journal names. This is the case for *J. Geophys. Res.* Moreover since *J. Geophys. Res.* has a new way to refer to an article (since 2002 it has no page number), then the ADS references need to be corrected. More generally, it is worth verifying each reference from the original publication (independently of BibTeX use).

The full LaTeX and BibTeX compilation is made in four steps:

1) `latex filename`	(stores the labels in the `.aux` file)
2) `bibtex filename`	(loads the bibliography in the `.bbl` file)
3) `latex filename`	(reads the .bbl, stores in the `.aux`)
4) `latex filename`	(replaces all labels)

where `filename` is the name of your LaTeX file (for example, the present file) **without** typing its `.tex` extension. If a `(?)` is still present in the output (at the place of a label), it means that this label has not been properly defined. (for example, LaTeX labels are case sensitive). Any undefined label has a warning written in the `console window` (it is better to have this window open by default, since LaTeX warning and error messages are very useful to localize the problem).

When the references are not changed, it is unnecessary to re-run BibTeX. When no new labels are added, running latex once is sufficient to refresh the LaTeX output. So, except for the first, and the final time (safest), running LaTeX once is sufficient in most cases to update the LaTeX output, if the compilation files created are not erased! For example BibTeX keeps the bibliography in the usual environment,
`\begin{thebibliography}{} ... \end{thebibliography}`
in the file with the `.bbl` extension.

5.2. Miscellaneous Other Features

Long URL's can be quite messy when broken across lines `http://gong.nso.edu/data/magmap/` as normal text, however the `url` package does a nice job of this, *e.g.* http://gong.nso.edu/data/magmap/.

6. Conclusion

We hope authors of *Solar Physics* will find this guide useful. Please send us feedback on how to improve it.

LaTeX is very convenient to write a scientific text, in particular with the use of labels for figures, tables, and references. Moreover, the labels and list of references are checked by the software against one another, and, the formatting should be effortless with BibTeX.

Appendix

After the `\appendix` command, the sections are referenced with capital letters. The numbering of equations, figures and labels is is just the same as with classical sections.

A. Abbreviations of some Journal Names

Journal names are abbreviated in *Solar Physics* with the IAU convention (IAU Style Book published in Transactions of the IAU XXB, 1988, pp. Si-S3. www.

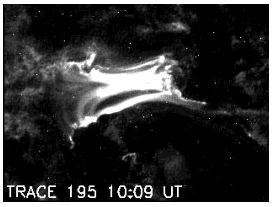

Figure 1. Example of a simple figure in an appendix.

Table 1. A simple table in an appendix.

Rot.	Date	CMEs obs.	CMEs cor.	α $10^{-2}\mathrm{Mm}^{-1}$
1	02–Nov–97	16	24.1	-1.26
2	29–Nov–97	–	2.53	0.94

iau.org/Abbreviations.235.0.html). Here are a few journals with their LaTeX commands (see the beginning of this `.tex` file).

`\aap`	*Astron. Astrophys.*
`\apj`	*Astrophys. J.*
`\jgr`	*J. Geophys. Res.*
`\mnras`	*Mon. Not. Roy. Astron. Soc.*
`\pasj`	*Pub. Astron. Soc. Japan*
`\pasp`	*Pub. Astron. Soc. Pac.*
`\solphys`	*Solar Phys.*

Acknowledgements The authors thank ... (*note the reduced point size*)

Bibliography Included with BibTeX

With BibTeX the formatting will be done automatically for all the references cited with one of the `\cite` commands (Section **??**). Besides the usual items, it includes the title of the article and the concluding page number.

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The articles can be entered, formatted, and ordered by the author with the command `\bibitem`. ADS provides references in the *Solar Physics* format by selecting the format `SoPh format` under the menu `Select short list format`. Including the article title and the concluding page number are optional; however, we require consistency in the author's choice. That is, all of the references should have the article title, or none, and similarly for ending page numbers.

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