

Dave Green's thesis template

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A dissertation submitted for the degree of Doctor of Philosophy

SUMMARY

Here is my template for PhD or other theses, for pdf \LaTeX (or \LaTeX , but pdf \LaTeX provides better internal hyperlinks).

It is based on the ‘ $\text{\textcolor{violet}{memoir}}$ ’ \LaTeX class, which has a lot of useful features/options built-in. The documentation for the memoir class says that ‘[it] provides the functionality of over thirty of the more popular packages, thus simplifying document sources’.

If there is any specific typesetting feature you want to use in your thesis, you should first check in the comprehensive manual for the memoir class via the link above (which has a detailed index). It may well be that what you want is already provided by the memoir class (and it is better to use its built-in capabilities, rather than loading additional style files, unless you have to).

The rest of this template show various examples of features available.

See <http://www.mrao.cam.ac.uk/~dag/THESIS/> for the current version of this template. (This version is V1.15, dated 2022 July.)

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DECLARATION

This is the declaration. This is not too long, honest!

ACKNOWLEDGEMENTS

These are the acknowledgements.

BASIC USE OF THE TEMPLATE

1.1 Introduction

Starting from the (unpacked) template, you need to edit the `thesis.tex` file to point to: (i) all the ‘frontmatter’ you want (titlepage, summary, etc); (ii) your particular chapters and appendices; (iii) the ‘backmatter’ (i.e. references). Note that when drafting, if you want to process one or a few chapters only, edit the ‘`\includeonly{...}`’ line in `thesis.tex` as needed. (Further commands that may be useful when writing your draft thesis are discussed in Chapter 3.)

1.2 Style options

Many aspects of the style of the thesis are set in `thesis.sty`, which you can change as you want, and some of the possibilities are explained in the comments in the file. These include:

- 1) chapter/section styles (see Chapter 6 of the [memoir](#) user manual, or the [memoirchapter-styles](#) L^AT_EX package for other styles) or specify a custom chapter style;
- 2) page header style (e.g. uppercase or not, underlined or not);
- 3) the default fonts use the ‘newtxtext’ and ‘newtxmath’ packages, which provide a full range of Times based fonts for text and mathematics – see Section 1.5 for examples – or you can choose other font packages;
- 4) the colours used for different types of hyperlinks (which are defined in `thesis.sty` using the `\hypersetup{...}` command; you can change to use darker colours or dark grey – e.g. for printing – by uncommenting the appropriate lines in `thesis.sty`).

There are various other settings in `thesis.sty`, which you can also adjust if you want, but I expect you are likely to stick with the defaults (e.g. the vertical spacing and label style of lists; the page size; the default figure/table captions font size/width; whether to list the bibliography in table of contents; what level of sections/subsections to list – numbered or not – in the table of contents; use lowercase letters not numbers for footnote labels^a; line spacing; vertical page formatting; settings controlling the display of figures/tables on a page).

1.3 References

The ‘natbib’ package^b is loaded by `thesis.sty` and various settings ‘natbib’ are made – which are conventional for astronomical references. Here are some example references, [Stephenson \(1971\)](#); [Stephenson & Green \(2002, 2003\)](#), and here are some more in parentheses ([Stephenson & Green 2005, 2009](#)).

1.4 URLs

This illustrates how to give a url <http://www.google.com/>, using the `\url{...}` command. (Or you can provide a link using some [text](#), which does not show the URL – which is probably not a good idea for a thesis – using the `\href{...}{...}` command.)

1.5 Mathematical fonts

The following illustrate some equations and the mathematical fonts available.

- 1) Mathematical symbols, as sloping font, including greek letters:

$$a^2 + b^2 = c^2, \quad A^2 + B^2 = C^2, \quad \alpha + \beta = \gamma, \quad \Gamma + \Delta = \Omega.$$

- 2) Vectors, as a bold sloping font (using `\vec{...}`):

$$a = \boldsymbol{b} \cdot \boldsymbol{c}, \quad A = \boldsymbol{B} \cdot \boldsymbol{C}, \quad \alpha + \beta = \gamma, \quad \boldsymbol{\Gamma} + \boldsymbol{\Delta} = \boldsymbol{\Omega}.$$

(Note: the default letter `v` looks very similar to the greek `ν` – ν compared with ν – so instead you can use `\varv`, which looks like v .)

- 3) An integral:

$$a^2 + b^2 = \int_0^\infty x^2 \mathrm{d}x.$$

^asuch as this.

^be.g. see <http://merkel.zoneo.net/Latex/natbib.php> for a reference list of the commands.

- 4) Upright greek letters are available. For example, with the ‘newtx’ fonts, use `\upmu` (inside maths mode), for units (such as μm , or $\mu\text{Jy beam}^{-1}$); use `\updelta` or `\upDelta` for increments (such as δx , Δy). Also available is `\uppartial` for an upright partial derivative, such as $\partial y/\partial x$.

1.6 Astronomical abbreviations

1.6.1 Coordinates

This illustrates several astronomical abbreviations that are defined in `thesis.sty` (as per journals), for use in maths mode only:

- `$12\degr 34\arcmin 56\arcsec$` gives $12^{\circ}34'56''$;
- `$12\fdg3, 45\farcm7, 78\farcs9$` gives $12^{\circ}.3, 45'.7, 78''.9$;
- `$12\fh3, 45\fm7, 78\fs9$` gives $12^{\text{h}}.3, 45^{\text{m}}.7, 78^{\text{s}}.9$;
- `$12\fp3$` gives $12^{\text{p}}.3$.

1.6.2 Ions

Also defined is `\ion{...}{...}` which can be used to specify ionised states of atoms. For example, `\ion{H}{II}` (or `\ion{H}{iii}`) gives ‘H II’.

If you frequently use particular ions, you may want to define macros for them in the preamble of your thesis (i.e. before the `\begin{document}` command). For example, including `\newcommand\HII{\ion{H}{II}}` defines the `\HII` command, which produces ‘ H II ’. (Note: if you use ‘`\HII`’ in a sentence – i.e. with a space after the `\HII` – then the space will be swallowed by \LaTeX ; instead use ‘`{\HII}`’ to preserve the following space.)

1.7 Section/list formatting

The rest of this chapter illustrates the formatting for sections, sub-sections, sub-sub-sections, and lists (both enumerated or not).

1.7.1 A subsection

Here is some sample text. Here is some sample text. Here is some sample text. Here is some
sample text. Here is some sample text. Here is some sample text. Here is some sample text.
Here is some sample text. Here is some sample text. Here is some sample text. Here is some
sample text. Here is some sample text.

1.7.1.1 Here is a sub-subsection

Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text.

1.7.1.2 Here is another sub-subsection

Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text.

1.7.2 Another subsection – lists

Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text.

- 1) Here is an example enumerated list. Here is an example enumerated list. Here is an example enumerated list. Here is an example enumerated list. Here is an example enumerated list.
 - a) Here is a second level list.
 - b) Here is an example enumerated list. Here is an example enumerated list. Here is an example enumerated list.
- 2) Here is an example enumerated list. Here is an example enumerated list.
- 3) Here is an example enumerated list. Here is an example enumerated list. Here is an example enumerated list. Here is an example enumerated list.

Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text.

- Here is an example list. Here is an example list. Here is an example list. Here is an example list. Here is an example list. Here is an example list.
- Here is an example list. Here is an example list.
- Here is an example list. Here is an example list. Here is an example list. Here is an example list.

Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text.

SECOND CHAPTER – EXAMPLE TABLES AND FIGURES – WHICH HAS A LONG TITLE (TOO LONG FOR THE HEADLINE/CONTENTS)

‘To err is human, but to really foul
things up you need a computer’

anonymous

2.1 Introduction

This Chapter illustrates the addition of a quotation on the first page of a Chapter (using the command `\epigraph{...}{...}`). Also, this Chapter has a long title – which is too long for the page headline/contents – but a shorter alternative was specified for the page headline/contents entry (using `\chapter[short title]{full title}`). Similarly shorter versions of Section headings etc. can be specified, if needed..

The rest of this chapter illustrates various styles for tables and figures.

2.2 Example tables

Table 2.1 and Table 2.2 are example tables that illustrate the use of the ‘d’ column specifier – which is defined in the `.tex` source – to align numbers by decimal places (as the ‘memoir’ class emulates the ‘dcolumn’ package).

Table 2.1: This is a simple example table.

number	reciprocal	cube
1	1	1
2	0.5	8
3	0.333	27
4	0.25	64

Note: here is a note to the table.

Table 2.2: This is a better example table.

number	reciprocal	cube
1	1	1
2	0.5	8
3	0.333	27
4	0.25	64

Note: here is a note to the table.

The difference between them is that Table 2.1 uses the default horizontal rules (i.e. `\hline`), whereas Table 2.2 uses alternate rules with better vertical spacing (i.e. `\toprule`, `\midrule` and `\bottomrule`), from the ‘booktabs’ package, which are emulated by the memoir class.

If you have a long table that spans more than one page, then use the `longtable` package. You will need to process the table through (pdf)LaTeX several times for the ‘longtable’ algorithm that decides on the column widths to converge. Landscape multiple-page tables can also be produced using ‘longtable’, provided you also load the ‘pdflscape’ package and place the table within `\begin{landscape}` and `\end{landscape}`. In both cases you will probably want to specify the caption width. Specify either `\setlength{\LTcapwidth}{\linewidth}` or `\narrowcaptionwidth` and `\setlength{\LTcapwidth}{\thesiscaptionwidth}`. If using the landscape environment, place these commands just after `\begin{landscape}`.

2.3 Example figures

This section illustrates various figure styles. Figure 2.1 shows a figure with a full width caption (using `\normalcaptionwidth`), whereas Figure 2.2 shows the slightly narrower caption width (`\narrowcaptionwidth`, which is the default). Figure 2.3 shows how to add ‘a), ‘b)’ ... labels to a figure with contains several sub-figures. Figure 2.4 shows a landscape figure (also using `\normalcaptionwidth`). Finally Figure 2.5 shows a 2×2 array of sub-figures, with the caption in one corner (which needs `\normalcaptionwidth`).

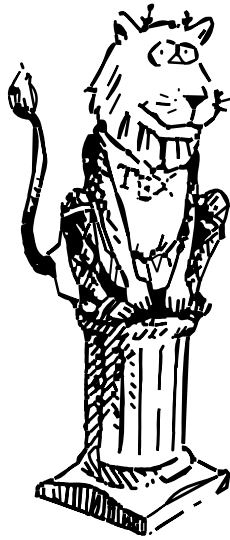


Figure 2.1: This shows a figure with a full width caption. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text.

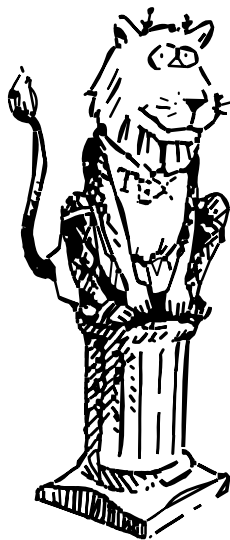


Figure 2.2: This shows a figure with a narrow width caption. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text.

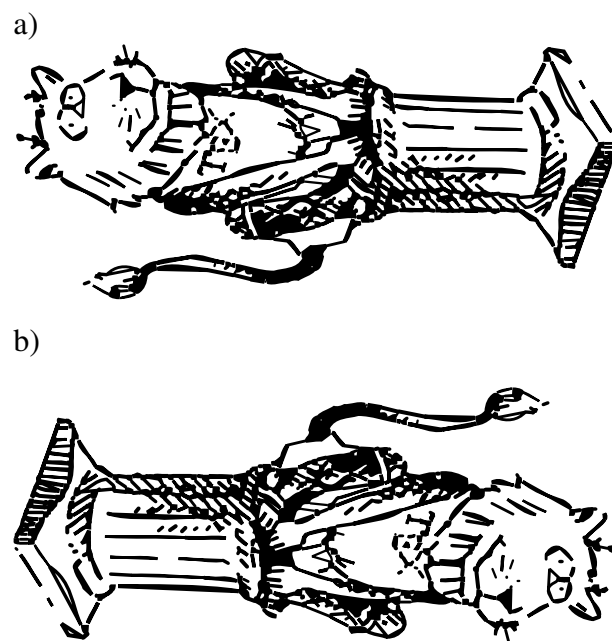


Figure 2.3: This shows a figure with including ‘a)’ and ‘b)’ labels for the sub-figures. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text.

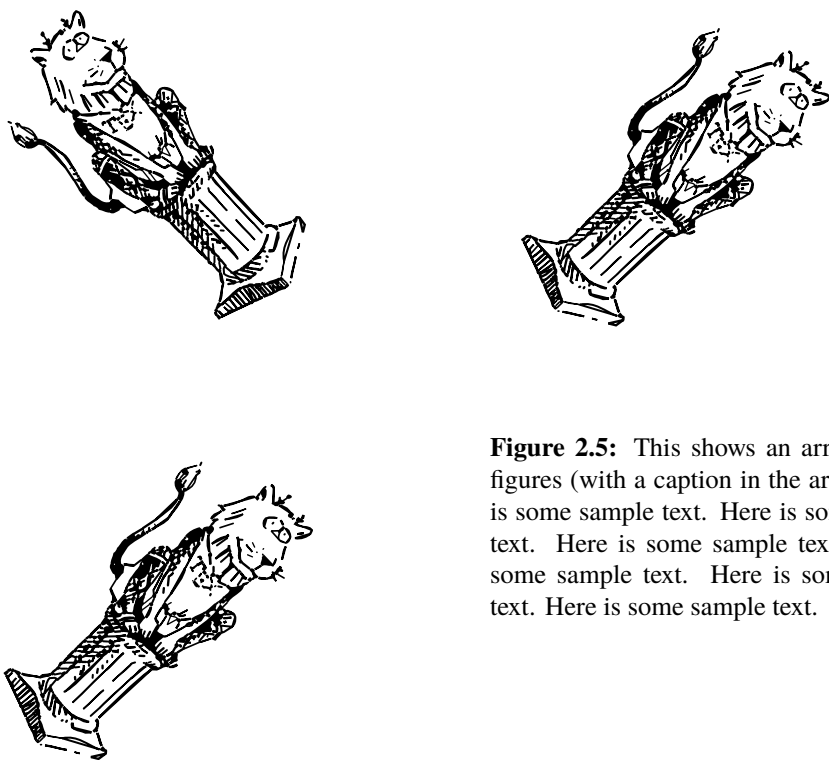


Figure 2.5: This shows an array of sub-figures (with a caption in the array). Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text.

USEFUL COMMANDS FOR DRAFTING

3.1 Introduction

This Chapter discusses various commands – some built into the memoir class, others defined in `thesis.sty`, and some requiring additional packages to be loaded – which may be useful when drafting. These include:

- 1) marginal notes (see Section 3.2);
- 2) marginal marks to indicate changes/deletions/additions (see Section 3.3);
- 3) the addition of line numbers (see Section 3.4.1);
- 4) adding a ‘watermark’ on each page, to timestamp a particular version (see Section 3.4.2).

3.2 Marginal notes

The `thesis.sty` file defines the `\note{...}` command for marginal notes (in a small font, black). In addition `\todo{...}` and `\tocheck{...}` are defined for specific notes/reminders on items still to do or check, which are shown as marginal notes in red and blue respectively, which are illustrated below.

this is an example
marginal note

Here is some sample text. Here is some sample text. Here is some sample text. Here is
some sample text. Here is some sample text. Here is some sample text. Here is some sample
text. Here is some sample text. Here is some sample text. Here is some sample text. Here is
some sample text. Here is some sample text. Here is some sample text. Here is some sample
text. Here is some sample text. Here is some sample text. Here is some sample text. Here is
some sample text. Here is some sample text. Here is some sample text.

To do: here is a note of something still to do

To check: here is a note about something to check

3.3 Changes/deletions/additions

The memoir class provides commands to mark changes, deletions or additions made, i.e. `\changed{...}`, `\deleted{...}` and `\added{...}` (see Chapter 18 of the [memoir](#) user manual for details). These add symbols with a text label to the margin to indicate revisions have been made (that is provided `\changemarks` rather than `\nochangemarks` is used, and that the draft option is used, or `\draftdoctrue` is set – otherwise these change marks are not shown).

Here is some sample text. Here is some sample text. Here is some sample text. Here is
some sample text. Here is some sample text. Here is some sample text. Here is some sample
text. Here is some sample text. Here is some sample text. Here is some sample text. Here is
some sample text. Here is some sample text. Here is some sample text. Here is some sample
text. Here is some sample text. Here is some sample text.

In addition, `thesis.sty` defines a command `\fixed{...}` which can be used to mark changed text, in green (along with ‘***’ added in the margin).

Here is some sample text. Here is some sample text. Here is some ‘fixed’ text. Here is some ‘fixed’ text. Here is some ‘fixed’ text. Here is some sample text.

3.4 Additional packages for drafting

3.4.1 Add line numbers

If you want to number the lines when drafting, then you can use the ‘lineno’ package. This is included towards the end of `thesis.sty`, but is commented out. If you want to use this package, the uncomment it in `thesis.sty`. Then you can switch linenumbers on or off with `\linenumbers` or `\nolinenumbers`. You can reset the line numbers – for example if you want to number the lines in each chapter from one – using `\resetlinenumbers`.

3.4.2 Add a ‘watermark’

If you want to add a ‘watermark’ to each page, to indicate the time/date of the draft version, you can use the ‘draftwatermark’ package. This is included towards the end of `thesis.sty` – along with commands to setup a faint grey ‘watermark’ in the left margin of each page saying ‘draft’ with the date and time – but is commented out. Uncomment and edit as needed the relevant lines in `thesis.sty` if you want to use a watermark when drafting.



THIS IS AN APPENDIX

A.1 Introduction

This is an example Appendix, with a couple of Sections. (The `.tex` for this Appendix starts with `\addtocontents{toc}{\clearpage}` to force a new page in the Table of Contents. You may want to use this – at the final stage – if the page breaks in your Table of Contents are in awkward places.)

A.2 Another section

Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text. Here is some sample text.



ANOTHER APPENDIX – A PAPER

This Appendix shows how to include another .pdf document (e.g. in this case, the first three pages a paper), using the `\includepdf{...}` command from the [pdfpages](#) package. This requires processing with pdf \LaTeX rather than \LaTeX .

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A colour scheme for the display of astronomical intensity images

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Abstract. I describe a colour scheme that is appropriate for the screen display of intensity images. This – unlike many currently available schemes – is designed to be monotonically increasing in terms of its perceived brightness. Also, when printed on a black and white postscript printer, the scheme results in a greyscale with monotonically increasing brightness. This scheme has recently been incorporated into the radio astronomical analysis packages CASA and AIPS.

Keywords : methods: data analysis – methods: miscellaneous

1. The problem

Images in astronomy often, but not always, represent the intensity of some source. However, the colour schemes used to display images are not perceived as increasing monotonically in brightness, which does not aid the interpretation of the images. The perceived brightness of red, green and blue are not the same, with green being seen as the brightest, then red, then blue. For example a bright yellow (i.e. full intensity red and green) is perceived as being very much brighter than a bright blue. So if a colour scheme has yellow for intermediate intensities, but blue or red for higher intensities, then the blue or red is perceived at lower brightness. This can be also seen when such colour images are printed in black and white, when increasing intensity in the image does not correspond to a greyscale with monotonically increasing brightness. This problem was noted by Rappaport (2002) for the colour schemes then available in the MATLAB¹ computing package. Rappaport constructed – in an *ad hoc* manner – a colour scheme² that does result in a greyscale with monotonically increasing brightness when printed on a black and white device.

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¹see: <http://www.mathworks.com/products/matlab/>

²see: <http://www.mathworks.com/matlabcentral/fileexchange/2662-cmrmap-m>

Here I describe colour schemes for the display of images that take into account the different perceptions of the brightnesses of red, green and blue, in order to maintain a monotonically increasing perception of intensity.

2. Background

An example of where colour needs to be converted to black and white, to preserve perceived brightness, is the addition of colour to black and white television. In the US, the National Television System Committee (NTSC) specifications from 1953, red, green and blue (hereafter R , G , B) are mapped to a Y ‘luma’ value (i.e. the black and white brightness) signal using (see, for example, Lee 2005 or Hunt 2004)

$$Y = 0.30R + 0.59G + 0.11B \quad (1)$$

(In addition there were two other components, ‘ Q ’ and ‘ I ’ which encoded the colour.)

The coefficients in equation 1 are appropriate for the colour phosphors then in use, and reflect the perceived intensity of the different colours. Modern monitors differ somewhat, but the coefficients of the different perceived intensities are similar, e.g. the European PAL colour TV standard uses very similar coefficients, with $Y = 0.299R + 0.587G + 0.114B$, and more recently HDTV uses $Y = 0.2126R + 0.7152G + 0.0722B$ (ITU-R Recommendation 709, originally from 1993). In all cases the perceived brightness of green is largest, then red, then blue.

The NTSC coefficients are also used: (1) to map from the DeviceRGB to DeviceGray colourspace used within Postscript if the `colorimage` operator is used with a black and white device³, and (2) to convert from colour to greyscale for greyscale only devices, within the PGPLOT package⁴.

3. A solution

In the 1980s, a colour scheme was implemented for the Sigma ARGS graphics display on the Cambridge STARLINK VAX, by a colleague, John Fielden. This was from black to white, spiralling around the greyscale diagonal in an R , G , B colour cube. However, this treated R , G , B equivalently, i.e. not taking into account these colours are perceived differently in terms of their brightness. I adapted this colour scheme so that it *is* monotonically increasing in terms of perceived brightness, according to equation 1.

The colour scheme – a squashed helix around the diagonal of a colour cube, ‘cubehelix’ – is implemented as follows. For a unit colour cube (i.e. 3-D coordinates for R , G , B , each in the

³PostScript Language Reference, Third Edition, see: <http://www.adobe.com/devnet/postscript/>

⁴Section 5.1 of the PGPLOT manual, see: <http://www.astro.caltech.edu/~tjp/pgplot/contents.html>

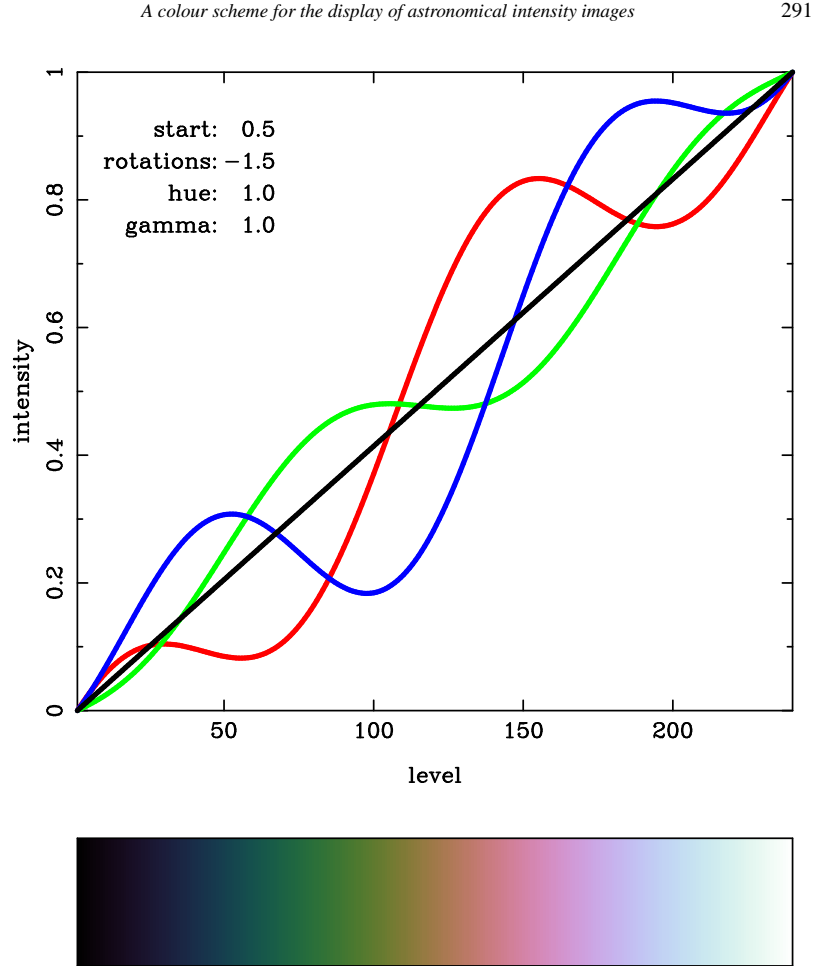


Figure 1. An example ‘cubehelix’ colour scheme with 256 colour levels, as recently added in CASA. Top: the variation in red, green and blue intensity, and the perceived intensity according to equation 1. Bottom: a colour wedge to illustrate the scheme. This has a start colour of 0.5, i.e. purple (which is between $R = 1$ and $B = 3 \equiv 0$ when using modulo 3 arithmetic, with $R = 1$, $G = 2$, $B = 3$), with -1.5 rotations, i.e. $\rightarrow B \rightarrow G \rightarrow R \rightarrow B$, a hue value of 1.2 (as with the chosen start colour and rotations this value does not lead to any clipping), and gamma of 1.0.

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