Template AASTeX Article with Examples: v6.31[*]

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ABSTRACT

This example manuscript is intended to serve as a tutorial and template for authors to use when writing their own AAS Journal articles. The manuscript includes a history of AASTeX and documents the new features in the previous versions as well as the bug fixes in version 6.31. This manuscript includes many figure and table examples to illustrate these new features. Information on features not explicitly mentioned in the article can be viewed in the manuscript comments or more extensive online documentation. Authors are welcome replace the text, tables, figures, and bibliography with their own and submit the resulting manuscript to the AAS Journals peer review system. The first lesson in the tutorial is to remind authors that the AAS Journals, the Astrophysical Journal (ApJ), the Astrophysical Journal Letters (ApJL), the Astronomical Journal (AJ), and the Planetary Science Journal (PSJ) all have a 250 word limit for the abstract[a]. If you exceed this length the Editorial office will ask you to shorten it. This abstract has 182 words.

Keywords: Classical Novae (251) — Ultraviolet astronomy(1736) — History of astronomy(1868) — Interdisciplinary astronomy(804)

1. INTRODUCTION

LaTeX [1] is a document markup language that is particularly well suited for the publication of mathematical and scientific articles (**?**). LaTeX was written in 1985 by Leslie Lamport who based it on the TeX typesetting language which itself was created by Donald E. Knuth in 1978. In 1988 a suite of LaTeX macros were developed to investigate electronic submission and publication of AAS Journal articles (**?**). Shortly afterwards, Chris Biemesdefer merged these macros and more into a LaTeX 2.08 style file called AASTeX. These early AASTeX versions introduced many common commands and practices that authors take for granted today. Substantial revisions were made by Lee Brotzman and Pierre Landau when the package was updated to v4.0. AASTeX v5.0, written in 1995 by Arthur Ogawa, upgraded to LaTeX 2e which uses the document class in lieu of a style file. Other improvements to version 5 included hypertext support, landscape deluxetables and improved figure support to facilitate electronic submission. AASTeX v5.2 was released in 2005 and introduced additional graphics support plus new mark up to identifier astronomical objects, datasets and facilities.

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[*] Released on March, 1st, 2021

[a] Abstracts for Research Notes of the American Astronomical Society (RNAAS) are limited to 150 words

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[1] http://www.latex-project.org/

In 1996 Maxim Markevitch modified the AAS preprint style file, aaspp4.sty, to closely emulate the very tight, two column style of a typeset Astrophysical Journal article. The result was emulateapj.sty. A year later Alexey Vikhlinin took over development and maintenance. In 2001 he converted emulateapj into a class file in LaTeX 2e and in 2003 Vikhlinin completely rewrote emulateapj based on the APS Journal's RevTEX class.

During this time emulateapj gained growing acceptance in the astronomical community as it filled an author need to obtain an approximate number of manuscript pages prior to submission for cost and length estimates. The tighter typeset also had the added advantage of saving paper when printing out hard copies.

Even though author publication charges are no longer based on print pages [2] the emulateapj class file has proven to be extremely popular with AAS Journal authors. An analysis of submitted LaTeX manuscripts in 2015 revealed that ∼65% either called emulateapj or have a commented emulateapj classfile call indicating it was used at some stage of the manuscript construction. Clearly authors want to have access to a tightly typeset version of the article when corresponding with co-authors and for preprint submissions.

When planning the next AASTeX release the popularity of emulateapj played an important roll in the decision to drop the old base code and adopt and modify emulateapj for AASTeX v6.+ instead. The change brings AASTeX inline with what the majority of authors are already using while still delivering new and improved features. AASTeX v6.0 through v6.31 were written by Amy Hendrickson. The release dates were January 2016 (v6.0), October 2016 (v6.1), January 2018 (v6.2), June 2019 (v6.3), and March 2010 (v6.31) respectively.

The new features in the recent releases includes:

- v6.0

    1. line numbering and watermarking,

    2. improved citations for third party data repositories and software,

    3. easier construction of matrix figures consisting of multiple encapsulated postscript (EPS) or portable document format (PDF) files,

    4. figure set mark up for large collections of similar figures,

    5. color mark up to easily enable/disable revised text highlighting,

    6. improved url support, and

    7. numerous table options such as the ability to hide columns, column decimal alignment, automatic column math mode and numbering, plus splitting of wide tables (see Section 3.1 for details).

- v6.1

    1. ORCID support for preprints,

    2. improved author, affiliation and collaboration mark up,

    3. reintroduced the old AASTeX v5.2 `\received`, `\revised`, `\accepted`, and `\published` commands plus added the new `\submitjournal` command to document which AAS Journal the manuscript was submitted to, plus

    4. new typeset style options including `modern`.

- v6.2

    1. A new RNAAS style option for Research Note manuscripts,

    2. Titles no longer put in all caps,

    3. No page skip between the title page and article body,

    4. re-introduce RevTeX's widetext environment for long lines in two column style formats, and

    5. upgrade to the `\doi` command.

- v6.3

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[2] see Section B in the Appendix for more details about how current article costs are calculated.

1. New `interactive` environment to highlight interactive figures (see Section 3.5.2),

2. Improved collaboration commands,

3. New `anonymous` style to keep the authors, affiliations and acknowledgments from showing in the compiled pdf for dual anonymous review, and

4. Adoptions of IAU approved syntax for nominal units, see Section D.

- v6.31

  1. Fixes a bug in the `anonymous` style for dual anonymous review.

  2. Improves line numbering with the `linenumbers` style around equations due to the amsmath and lineno package compatibility issues.

  3. Depreciate the `\\acknowledgment` command in favor of the `acknowledgment` environment.

The rest of this article provides information and examples on how to create your own AAS Journal manuscript with v6.31. Special emphasis is placed on how to use the full potential of AASTeX v6+. The next section describes the different manuscript styles available and how they differ from past releases. Section 3 describes table and figure placement. Specific examples of tables, Section 3.1, and figures, Section 3.2, are also provided. A special emphasis is placed on interactive figures. Section 4 discusses how to display math and incorporate equations in a manuscript while Section 5 discuss how to use different ways to highlight revisions. The last section, 6, shows how recognize software and external data as first class references in the manuscript bibliography. An appendix is included for additional information readers might find useful. More documentation is embedded in the comments of this LaTeX file and in the online documentation at http://journals.aas.org/authors/aastex.html.

2. MANUSCRIPT STYLES

The default style in AASTeX v6.31 is a tight single column style, e.g. 10 point font, single spaced. The single column style is very useful for article with wide equations. It is also the easiest to style to work with since figures and tables, see Section 3, will span the entire page, reducing the need for address float sizing.

To invoke a two column style similar to the what is produced in the published PDF copy use

`\documentclass[twocolumn]{aastex631}`.

Note that in the two column style figures and tables will only span one column unless specifically ordered across both with the "*" flag, e.g.

`\begin{figure*}` ... `\end{figure*}`,
`\begin{table*}` ... `\end{table*}`, and
`\begin{deluxetable*}` ... `\end{deluxetable*}`.

This option is ignored in the onecolumn style.

Some other style options are outlined in the commented sections of this article. Any combination of style options can be used.

Two style options that are needed to fully use the new revision tracking feature, see Section 5, are `linenumbers` which uses the lineno style file to number each article line in the left margin and `trackchanges` which controls the revision and commenting highlight output.

There is also a new `modern` option that uses a Daniel Foreman-Mackey and David Hogg design to produce stylish, single column output that has wider left and right margins. It is designed to have fewer words per line to improve reader retention. It also looks better on devices with smaller displays such as smart phones.

The `anonymous` option will prevent the author and affiliations from being shown in the compiled pdf copy. This option allows the author to keep this critical information in the latex file but prevent the reviewer from seeing it during peer review if dual anonymous review (DAR) is requested. Likewise, acknowledgments can also be hidden if placed in the new `\begin{acknowledgments}` ... `\end{acknowledgments}` environment. The use of this option is highly recommended for PSJ submissions. Advice for anonymizing your manuscript for DAR is provided at https://journals.aas.org/manuscript-preparation/#dar.

3. FLOATS

Floats are non-text items that generally can not be split over a page. They also have captions and can be numbered for reference. Primarily these are figures and tables but authors can define their own. LaTeX tries to place a float where indicated in the manuscript but will move it later if there is not enough room at that location, hence the term "float".

Authors are encouraged to embed their tables and figures within the text as they are mentioned. Please do not place the figures and text at the end of the article as was the old practice. Editors and the vast majority of referees find it much easier to read a manuscript with embedded figures and tables.

Depending on the number of floats and the particular amount of text and equations present in a manuscript the ultimate location of any specific float can be hard to predict prior to compilation. It is recommended that authors textbfnot spend significant time trying to get float placement perfect for peer review. The AAS Journal's publisher has sophisticated typesetting software that will produce the optimal layout during production.

Note that authors of Research Notes are only allowed one float, either one table or one figure.

For authors that do want to take the time to optimize the locations of their floats there are some techniques that can be used. The simplest solution is to placing a float earlier in the text to get the position right but this option will break down if the manuscript is altered. A better method is to force LaTeX to place a float in a general area with the use of the optional `[placement specifier]` parameter for figures and tables. This parameter goes after `\begin{figure}`, `\begin{table}`, and `\begin{deluxetable}`. The main arguments the specifier takes are "h", "t", "b", and "!". These tell LaTeX to place the float here (or as close as possible to this location as possible), at the top of the page, and at the bottom of the page. The last argument, "!", tells LaTeX to override its internal method of calculating the float position. A sequence of rules can be created by using multiple arguments. For example, `\begin{figure}[htb!]` tells LaTeX to try the current location first, then the top of the page and finally the bottom of the page without regard to what it thinks the proper position should be. Many of the tables and figures in this article use a placement specifier to set their positions.

Note that the LaTeX `tabular` environment is not a float. Only when a `tabular` is surrounded by `\begin{table}` ... `\end{table}` is it a true float and the rules and suggestions above apply.

In AASTeX v6.31 all deluxetables are float tables and thus if they are longer than a page will spill off the bottom. Long deluxetables should begin with the `\startlongtable` command. This initiates a longtable environment. Authors might have to use `\clearpage` to isolate a long table or optimally place it within the surrounding text.

3.1. *Tables*

Tables can be constructed with LaTeX's standard table environment or the AASTeX's deluxetable environment. The deluxetable construct handles long tables better but has a larger overhead due to the greater amount of defined mark up used set up and manipulate the table structure. The choice of which to use is up to the author. Examples of both environments are used in this manuscript.

Tables longer than 200 data lines and complex tables should only have a short example table with the full data set available in the machine readable format. The machine readable table will be available in the HTML version of the article with just a short example in the PDF. Authors are required to indicate in the table comments that the data in machine readable format in the full article. Authors are encouraged to create their own machine readable tables using the online tool at http://authortools.aas.org/MRT/upload.html.

AASTeX v6 introduced five new table features that were designed to make table construction easier and the resulting display better for AAS Journal authors. The items are:

1. Declaring math mode in specific columns,

2. Column decimal alignment,

3. Automatic column header numbering,

4. Hiding columns, and

5. Splitting wide tables into two or three parts.

Full details on how to create each type are given in the following sections. Additional details are available in the AASTeX guidelines at http://journals.aas.org/authors/aastex.html

3.1.1. *Column math mode*

Both the LaTeX tabular and AASTeX deluxetable require an argument to define the alignment and number of columns. The most common values are "c", "l" and "r" for center, left, and right justification. If these values are capitalized, e.g. "C", "L", or "R", then that specific column will automatically be in math mode meaning that \$s are not required. Note that having embedded dollar signs in the table does not affect the output.

3.1.2. *Decimal alignment*

Aligning a column by the decimal point can be difficult with only center, left, and right justification options. It is possible to use phantom calls in the data, e.g. `\phn`, to align columns by hand but this can be tedious in long or complex tables. To address this AASTeX introduces the `\decimals` command and a new column justification option, "D", to align data in that column on the decimal. In deluxetable the `\decimals` command is invoked before the `\startdata` call but can be anywhere in LaTeX's tabular environment.

Two other important thing to note when using decimal alignment is that each decimal column *must end with a space before the ampersand*, e.g. "&&" is not allowed. Empty decimal columns are indicated with a decimal, e.g. ".". Do not use deluxetable's `\nodata` command.

The "D" alignment token works by splitting the column into two parts on the decimal. While this is invisible to the user one must be aware of how it works so that the headers are accounted for correctly. All decimal column headers need to span two columns to get the alignment correct. This can be done with a multicolumn call, e.g `\multicolumn2c{}` or `\multicolumn{2}{c}{}`, or use the new `\twocolhead{}` command in deluxetable. Since LaTeX is splitting these columns into two it is important to get the table width right so that they appear joined on the page. You may have to run the LaTeX compiler twice to get it right.

3.1.3. *Automatic column header numbering*

The command `\colnumbers` can be included to automatically number each column as the last row in the header. Per the AAS Journal table format standards, each column index numbers will be surrounded by parentheses. In a LaTeX tabular environment the `\colnumbers` should be invoked at the location where the author wants the numbers to appear, e.g. after the last line of specified table header rows. In deluxetable this command has to come before `\startdata`. `\colnumbers` will not increment for columns hidden by the "h" command, see Section 3.1.4.

Note that when using decimal alignment in a table the command `\decimalcolnumbers` must be used instead of `\colnumbers` and `\decimals`.

3.1.4. *Hiding columns*

Entire columns can be hidden from display simply by changing the specified column identifier to "h". In the LaTeX tabular environment this column identifier conceals the entire column including the header columns. In AASTeX's deluxetables the header row is specifically declared with the `\tablehead` call and each header column is marked with `\colhead` call. In order to make a specific header disappear with the "h" column identifier in deluxetable use `\nocolhead` instead to suppress that particular column header.

Authors can use this option in many different ways. Since column data can be easily suppressed authors can include extra information and hid it based on the comments of co-authors or referees. For wide tables that will have a machine readable version, authors could put all the information in the LaTeX table but use this option to hid as many columns as needed until it fits on a page. This concealed column table would serve as the example table for the full machine readable version. Regardless of how columns are obscured, authors are responsible for removing any unneeded column data or alerting the editorial office about how to treat these columns during production for the final typeset article.

Table 1 provides some basic information about the first ten Messier Objects and illustrates how many of these new features can be used together. It has automatic column numbering, decimal alignment of the distances, and one concealed column. The Common name column is the third in the LaTeX deluxetable but does not appear when the article is compiled. This hidden column can be shown simply by changing the "h" in the column identifier preamble to another valid value. This table also uses `\tablenum` to renumber the table because a LaTeX tabular table was inserted before it.

Table 1. Fun facts about the first 10 messier objects

Messier Number (1)	NGC/IC Number (2)	Object Type (3)	Distance (kpc) (4)	Constellation (5)	V (mag) (6)
M1	NGC 1952	Supernova remnant	2	Taurus	8.4
M2	NGC 7089	Cluster, globular	11.5	Aquarius	6.3
M3	NGC 5272	Cluster, globular	10.4	Canes Venatici	6.2
M4	NGC 6121	Cluster, globular	2.2	Scorpius	5.9
M5	NGC 5904	Cluster, globular	24.5	Serpens	5.9
M6	NGC 6405	Cluster, open	0.31	Scorpius	4.2
M7	NGC 6475	Cluster, open	0.3	Scorpius	3.3
M8	NGC 6523	Nebula with cluster	1.25	Sagittarius	6.0
M9	NGC 6333	Cluster, globular	7.91	Ophiuchus	8.4
M10	NGC 6254	Cluster, globular	4.42	Ophiuchus	6.4

Note—This table "hides" the third column in the LaTeX when compiled. The Distance is also centered on the decimals. Note that when using decimal alignment you need to include the `\decimals` command before `\startdata` and all of the values in that column have to have a space before the next ampersand.

3.1.5. *Splitting a table into multiple horizontal components*

Since the AAS Journals are now all electronic with no print version there is no reason why tables can not be as wide as authors need them to be. However, there are some artificial limitations based on the width of a print page. The old way around this limitation was to rotate into landscape mode and use the smallest available table font sizes, e.g. `\tablewidth`, to get the table to fit. Unfortunately, this was not always enough but now along with the hide column option outlined in Section 3.1.4 there is a new way to break a table into two or three components so that it flows down a page by invoking a new table type, splittabular or splitdeluxetable. Within these tables a new "B" column separator is introduced. Much like the vertical bar option, "|", that produces a vertical table lines the new "B" separator indicates where to Break a table. Up to two "B"s may be included.

Table 2 shows how to split a wide deluxetable into three parts with the `\splitdeluxetable` command. The `\colnumbers` option is on to show how the automatic column numbering carries through the second table component, see Section 3.1.3.

3.2. *Figures*

Authors can include a wide number of different graphics with their articles but encapsulated postscript (EPS) or portable document format (PDF) are encouraged. These range from general figures all authors are familiar with to new enhanced graphics that can only be fully experienced in HTML. The later include figure sets, animations and interactive figures. All enhanced graphics require a static two dimensional representation in the manuscript to serve as the example for the reader. All figures should include detailed and descriptive captions. These captions are absolutely critical for readers for whom the enhanced figure is inaccessible either due to a disability or offline access. This portion of the article provides examples for setting up all these types in with the latest version of AASTeX.

3.3. *General figures*

AASTeX has a `\plotone` command to display a figure consisting of one EPS/PDF file. Figure 1 is an example which shows the approximate changes in the subscription costs and author publication charges from 1991 to 2013 in the AAS Journals. For a general figure consisting of two EPS/PDF files the `\plottwo` command can be used to position the two image files side by side.

Table 5. Measurements of Emission Lines: two breaks

Model	Component	Shift	FWHM	Flux		
		(km s^{-1})	(km s^{-1})	(10^{-17} erg s^{-1} cm^{-2})		
				Lyα		
(1)	(2)	(3)	(4)	(5)		
	BELs	-97.13	9117±38	1033±33		
Model 1	IELs	-4049.123	1974±22	2495±30		
	NELs	⋯	641±4	449±23		
	BELs	-85	8991±41	988±29		
Model 2	IELs	-51000	2025±26	2494±32		
	NELs	52	637±10	477±17		

N V	Si IV	C IV	Mg II	Hγ
(6)	(7)	(8)	(9)	(10)
< 35	< 166	637±31	1951±26	991±30
< 42	< 109	995±186	83±30	75±23
< 6	< 9	–	275±18	150±11
< 24	< 173	623±28	1945±29	989±27
< 37	< 124	1005±190	72±28	72±21
< 4	< 8	–	278±17	153±10

Hβ	Hα	He I	Paγ
(11)	(12)	(13)	(14)
3502±42	20285±80	2025±116	1289±107
130±25	357±94	194±64	36±23
313±12	958±43	318±34	151±17
3498±37	20288±73	2047±143	1376±167
113±18	271±85	205±72	34±21
317±15	969±40	325±37	147±22

NOTE—This is an example of how to split a deluxetable. You can split any table with this command into two or three parts. The location of the split is given by the author based on the placement of the "B" indicators in the column identifier preamble. For more information please look at the new AASTEX instructions.

Both \plotone and \plottwo take a \caption and an optional \figurenum command to specify the figure number[3]. Each is based on the graphicx package command, \includegraphics. Authors are welcome to use \includegraphics along with its optional arguments that control the height, width, scale, and position angle of a file within the figure. More information on the full usage of \includegraphics can be found at https://en.wikibooks.org/wiki/LaTeX/Importing_Graphics#Including_graphics.

3.4. Grid figures

Including more than two EPS/PDF files in a single figure call can be tricky to easily format. To make the process easier for authors AASTEX v6 offers \gridline which allows any number of individual EPS/PDF file calls within a single figure. Each file cited in a \gridline will be displayed in a row. By adding more \gridline calls an author can easily construct a matrix X by Y individual files as a single general figure.

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[3] It is better to not use \figurenum and let LaTeX auto-increment all the figures. If you do use this command you need to mark all of them accordingly.
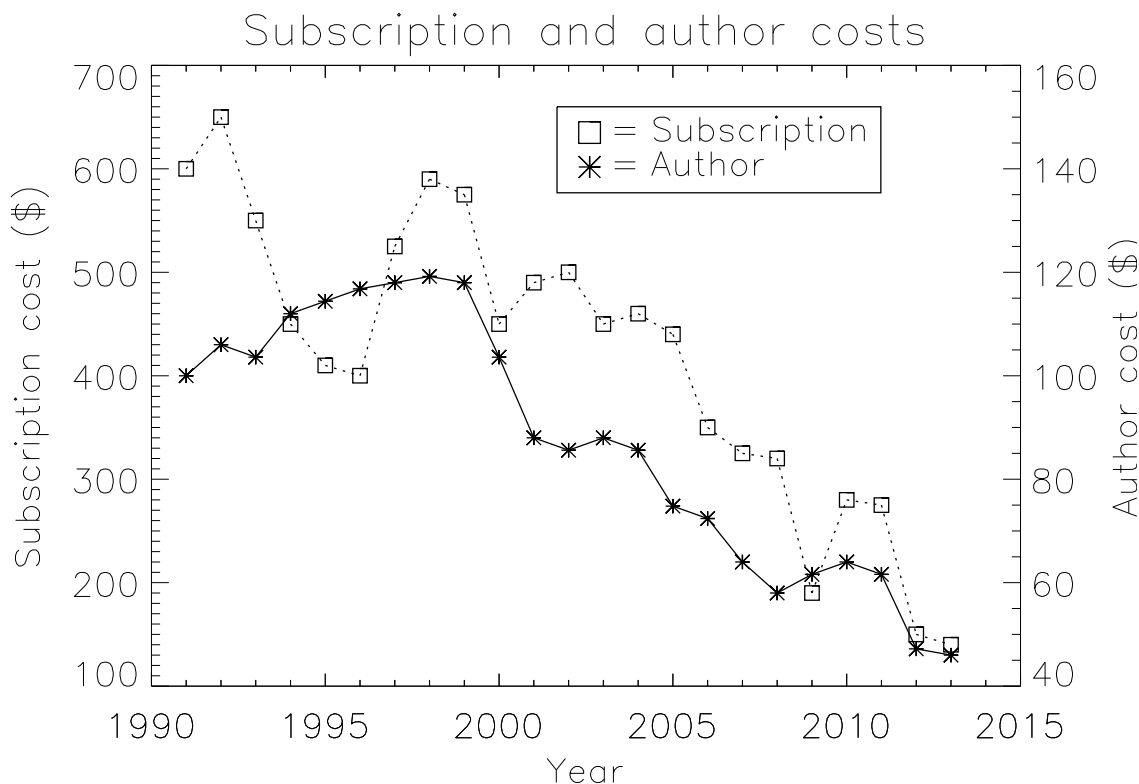
Figure 1. The subscription (squares) and author publication (asterisks) costs from 1991 to 2013. Subscription cost are on the left Y axis while the author costs are on the right Y axis. All numbers in US dollars and adjusted for inflation. The author charges also account for the change from page charges to digital quanta in April 2011.

For each `\gridline` command a EPS/PDF file is called by one of four different commands. These are `\fig`, `\rightfig`, `\leftfig`, and `\boxedfig`. The first file call specifies no image position justification while the next two will right and left justify the image, respectively. The `\boxedfig` is similar to `\fig` except that a box is drawn around the figure file when displayed. Each of these commands takes three arguments. The first is the file name. The second is the width that file should be displayed at. While any natural LaTeX unit is allowed, it is recommended that author use fractional units with the `\textwidth`. The last argument is text for a subcaption.

Figure 2 shows an inverted pyramid of individual figure constructed with six individual EPS files using the `\gridline` option.

3.5. *Enhanced graphics*

Enhanced graphics have an example figure to serve as an example for the reader and the full graphical item available in the published HTML article. This includes Figure sets, animations, and interactive figures. The Astronomy Image Explorer (http://www.astroexplorer.org/) provides access to all the figures published in the AAS Journals since they offered an electronic version which was in the mid 1990s. You can filter image searches by specific terms, year, journal, or type. The type filter is particularly useful for finding all published enhanced graphics. As of March 2021 there are over 4000 videos, 1300 figure sets, and 100 interactive figures. The next sections describe how to include these types of graphics in your own manuscripts.

3.5.1. *Figure sets*

The grid commands given above works great for a limited set of individual figure files but what do you do if you have many 10s or 100s or even 1000s of individual figure files? Figure sets represents a virtual flip book of a large group of similar style figures. The derived PDF article will only shows an example figure while the enhanced content is available in the figure set in the HTML edition. The advantage of a figure set gives the reader the ability to easily sort
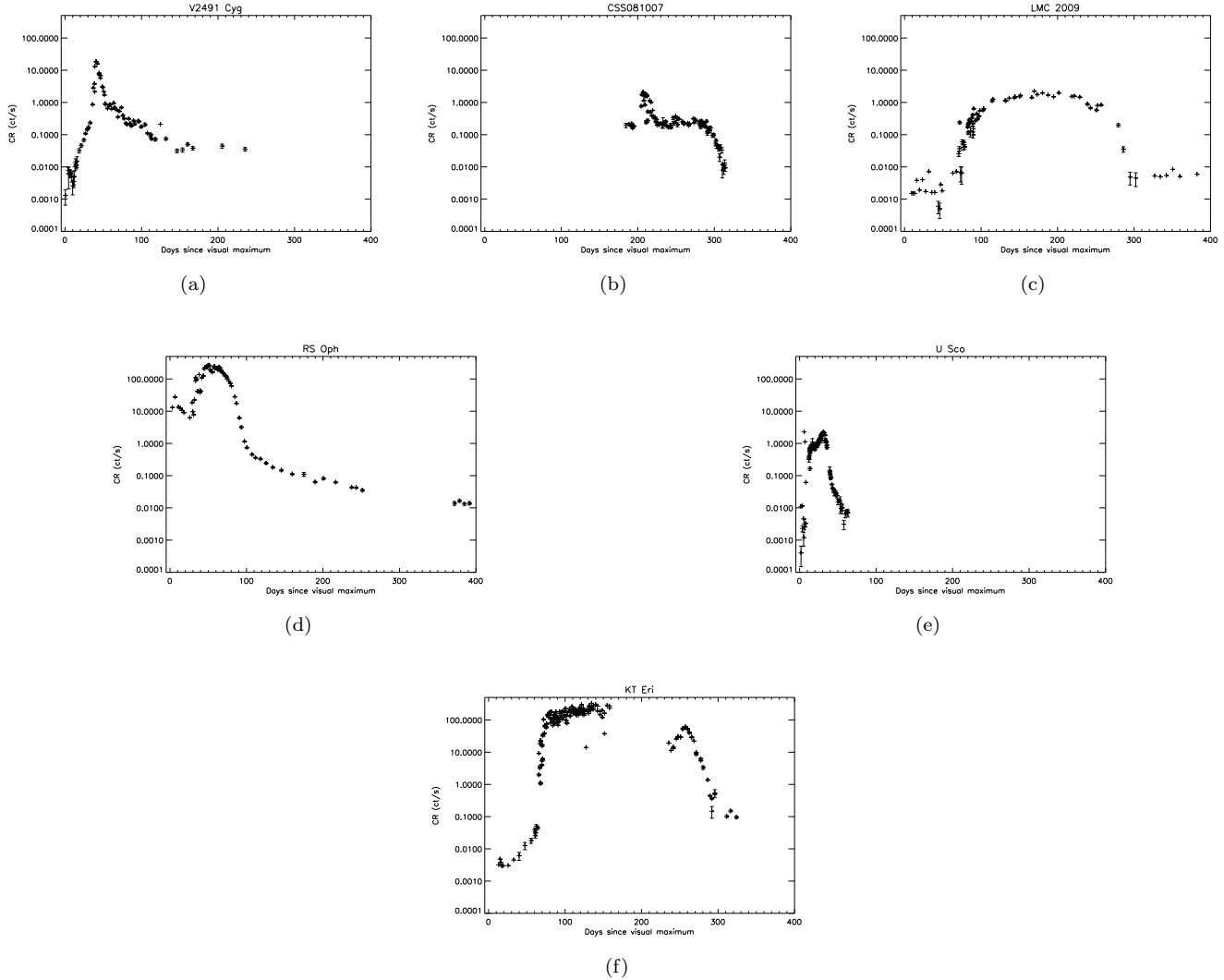
Figure 2. Inverted pyramid figure of six individual files. The nova are (a) V2491 Cyg, (b) HV Cet, (c) LMC 2009, (d) RS Oph, (e) U Sco, and (f) KT Eri. These individual figures are taken from **?**.

through a large collection to find individual component figures. The advantage to the author is that grouping similar figures into a figure set can result in significant cost savings in terms of reduced publication charges, see Appendix B. All of the figure set components, along with their html framework, are also available to the reader for download in a single .tar.gz package.

Special LaTeX mark up is required to create a figure set. Prior to AASTeX v6 the underlying mark up commands had to be inserted by hand but is now included. Note that when an article with figure set is compiled in LaTeX none of the component figures are shown and a floating Figure Set caption will appear in the resulting PDF.

Fig. Set 4.   Swift X-ray light curves

Authors are encouraged to use an online tool at http://authortools.aas.org/FIGSETS/make-figset.html to generate their own specific figure set mark up to incorporate into their LaTeX articles.

3.5.2. *Animations*

Authors may, and are in fact encouraged, to include animations in their manuscripts. The video will stream inline with the published article and also be available for download. When writing the manuscript, a stand alone figure is necessary to serve as an example for the reader. Ideally, this is a single still frame from the animation but in some case the animation may only represent a small portion of the example figure, say one many panels as shown in Figure
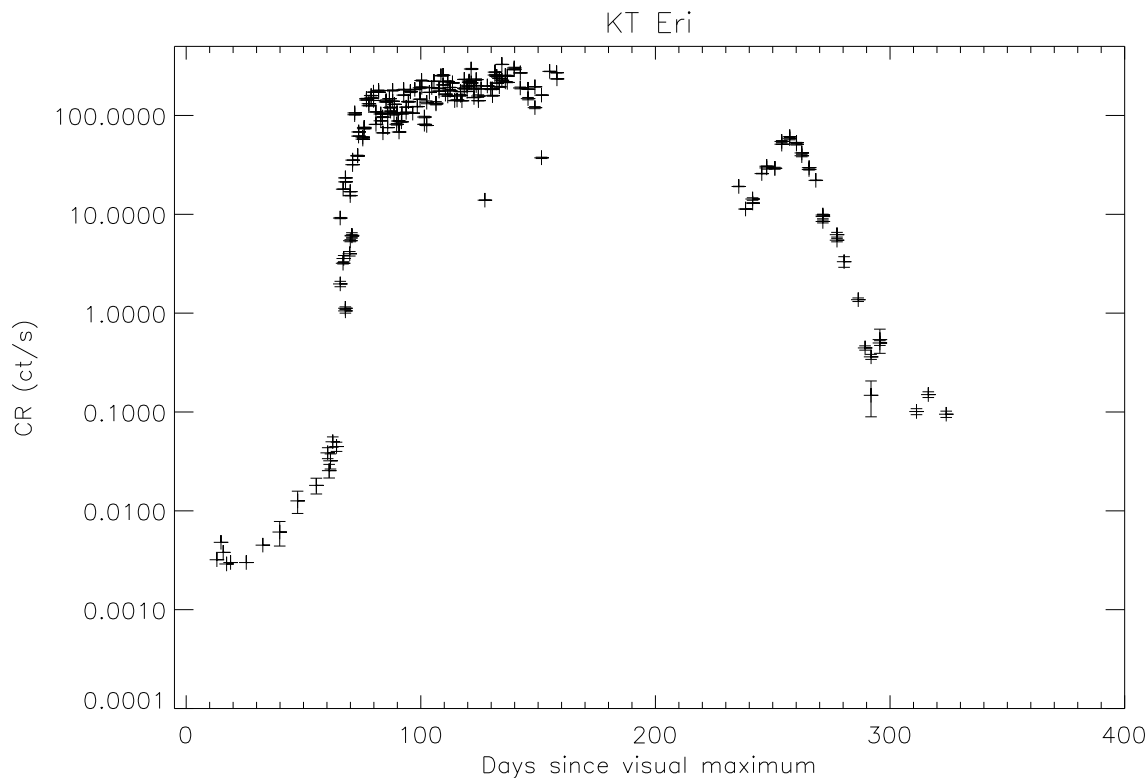
Figure 3. The Swift/XRT X-ray light curve for the first year after outburst of the suspected recurrent nova KT Eri. At a maximum count rate of 328 ct/s, KT Eri was the brightest nova in X-rays observed to date. All the component figures (6) are available in the Figure Set. Note that these components that are **not** shown in the compiled pdf. The figure set consists of the same figures as shown in Figure 2. The example figure shown for figure sets can be one component or many.

4. Regardless, it is very important that the author provide descriptive text in the figure caption including start and stop times and the video duration. Authors should review the AAS animation guidelines in the graphics guide at https://journals.aas.org/graphics-guide/#animations.

Animations and interactive figures (Section 3.5.3) should use the `\begininteractive` environment in the figure call. This environment places a blue border around the figure to indicate that the figure is enhanced in the published HTML article. The command also serves to alert the publisher what files are used to generate the dynamic HTML content. `\interactive` takes two arguments. The first details the type and currently only three are allowed. The types are `js` for generic javascript interactive figures, `animation` for inline videos, and `timeseries` for interactive light curves produced by astropy **?**[4]. If these types are not provide the compiler will issue an error and quit. The second argument is the file that produces the enhanced feature in the HTML article.

3.5.3. *Interactive figures*

Interactive figures give the reader the ability to manipulate the information contained in an image which can add clarity or help further the author's narrative. These figures consist of two parts, a static representative figure for the manuscript and the dynamic javascript plus HTML framework that allows for interactive control.

An example of an interactive figure is a 3D model. The underlying figure is a X3D file while x3dom.js is the javascript driver that displays it. An author created interface is added via a html wrapper. The first 3D model published by the AAS Journals using this technique was **?**.

Figure 5 provides an interactive example which can be run locally to demonstrate how a simple javascript plus html interface allows a reader to switch between figures. The necessary files for this particular interactive figure are in the

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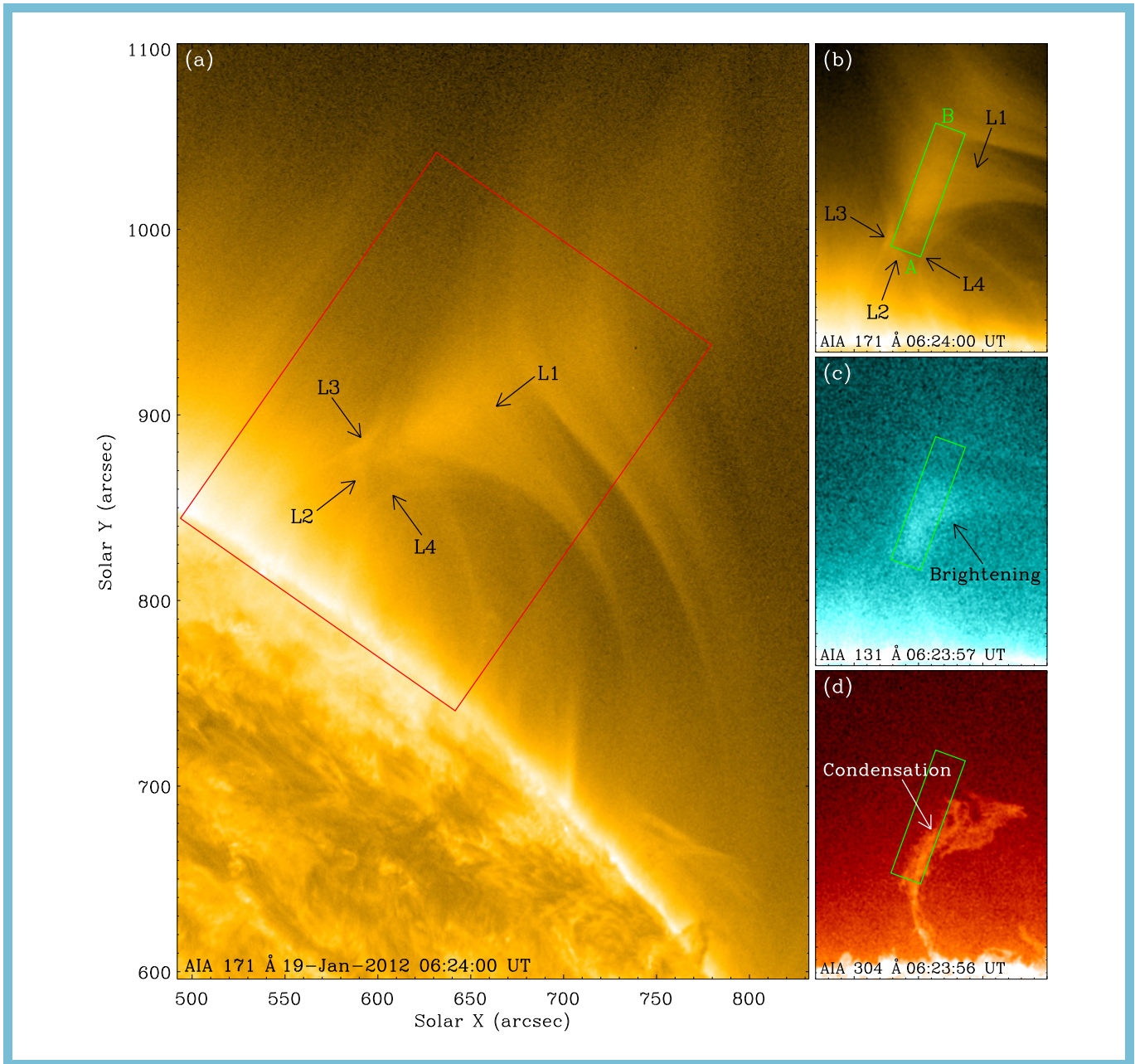[4] To be release in the summer of 2019

Figure 4. Figure 1 from **?**. AIA 171Å(a,b), AIA 131Å(c), and AIA 304Åimages are shown. The red rectangle in (a) shows the field of view of the other panels. An animation of panels (b-d) is available. It covers 8 hours of observing beginning at 01:00 UT on 2012 January 19. The video duration is 20 seconds.

`interactive.tar.gz` file included with this package. Unpack the file and point the browser to the local html file. In this case, the javascript that runs the interactive buttons is embedded in the html file but it could just as easily be calls to external javascript libraries. Ideally, the javascript should be included with the submitted package of interactive files to minimize external dependencies within the published article.

Authors should consult the online tutorials at https://journals.aas.org/graphics-guide/#interactive_figures for more information on what is currently supported and links to tutorials and examples.

4. DISPLAYING MATHEMATICS

Figure 5. Figure 4 from **?**. *Upper panel*: the cumulative median observing time to measure the 3σ RV masses of TESS planets as a function of host star spectral type and up to 10^3 hours. The *dashed blue curves* represent the results from the optical spectrograph whereas the *solid red curves* represent the near-IR spectrograph. *Lower panel*: the time derivative of the cumulative observing time curves used to indicate the RV planet detection efficiency. The *horizontal dashed line* highlights the value of the detection efficiency at 20 hours per detection. Note that unlike the lower panels, the upper panels do not share a common ordinate due to the differing number of planet detections around stars in each spectral type bin. The interactive version has two buttons that allows one to turn the optical and NIR layers.

The most common mathematical symbols and formulas are in the amsmath package. AASTeX requires this package so there is no need to specifically call for it in the document preamble. Most modern LaTeX distributions already contain this package. If you do not have this package or the other required packages, revtex4-1, latexsym, graphicx, amssymb, longtable, and epsf, they can be obtained from http://www.ctan.org

Mathematics can be displayed either within the text, e.g. $E = mc^2$, or separate from in an equation. In order to be properly rendered, all inline math text has to be declared by surrounding the math by dollar signs (\$).

A complex equation example with inline math as part of the explanation follows.

$$\bar{v}(p_2, \sigma_2) P_{-\tau} \hat{a}_1 \hat{a}_2 \cdots \hat{a}_n u(p_1, \sigma_1), \tag{1}$$

where p and σ label the initial $e^{\pm}$ four-momenta and helicities ($\sigma = \pm 1$), $\hat{a}_i = a_i^\mu \gamma_\nu$ and $P_\tau = \frac{1}{2}(1 + \tau \gamma_5)$ is a chirality projection operator ($\tau = \pm 1$). This produces a single line formula. LaTeX will auto-number this and any subsequent equations. If no number is desired then the `equation` call should be replaced with `displaymath`.

LaTeX can also handle a a multi-line equation. Use `eqnarray` for more than one line and end each line with a \\. Each line will be numbered unless the \\ is preceded by a `\nonumber` command. Alignment points can be added with ampersands (&). There should be two ampersands per line. In the examples they are centered on the equal symbol.

$$\gamma^\mu = \begin{pmatrix} 0 & \sigma_+^\mu \\ \sigma_-^\mu & 0 \end{pmatrix}, \gamma^5 = \begin{pmatrix} -1 & 0 \\ 0 & 1 \end{pmatrix}, \tag{2}$$

$$\sigma_\pm^\mu = (\mathbf{1}, \pm\sigma), \tag{3}$$

$$\hat{a} = \begin{pmatrix} 0 & (\hat{a})_+ \\ (\hat{a})_- & 0 \end{pmatrix},$$

$$(\hat{a})_\pm = a_\mu \sigma_\pm^\mu \tag{4}$$

5. REVISION TRACKING AND COLOR HIGHLIGHTING

Authors sometimes use color to highlight changes to their manuscript in response to editor and referee comments. In AASTeX new commands have been introduced to make this easier and formalize the process.

The first method is through a new set of editing mark up commands that specifically identify what has been changed. These commands are `\added{<text>}`, `\deleted{<text>}`, and `\replaced{<old text>}{<replaced text>}`. To activate these commands the `trackchanges` option must be used in the `\documentclass` call. When compiled this will produce the marked text in red. The `\explain{<text>}` can be used to add text to provide information to the reader describing the change. Its output is purple italic font. To see how `\added{<important added info>}`, `\deleted{<this can be deleted text>}`, `\replaced{<old data>}{<replaced data>}`, and `\explain{<text explaining the change>}` commands will produce important added information and replaced data, toggle between versions compiled with and without the `trackchanges` option.

A summary list of all these tracking commands can be produced at the end of the article by adding the `\listofchanges` just before the `\end{document}` call. The page number for each change will be provided. If the `linenumbers` option is also included in the documentclass call then not only will all the lines in the article be numbered for handy reference but the summary list will also include the line number for each change.

The second method does not have the ability to highlight the specific nature of the changes but does allow the author to document changes over multiple revisions. The commands are `\edit1{<text>}`, `\edit2{<text>}` and `\edit3{<text>}` and they produce `<text>` that is highlighted in bold, bold+italic and bold+underline, respectively. Authors should use the first command to **indicated which text has been changed from the first revision.** The second command is to highlight *new or modified text from a second revision*. If a third revision is needed then the last command should be used <u>to show this changed text</u>. Since over 90% of all manuscripts are accepted after the 3rd revision these commands make it easy to identify what text has been added and when. Once the article is accepted all the highlight color can be turned off simply by adding the `\turnoffediting` command in the preamble. Likewise, the new commands `\turnoffeditone`, `\turnoffedittwo`, and `\turnoffeditthree` can be used to only turn off the `\edit1{<text>}`, `\edit2{<text>}` and `\edit3{<text>}`, respectively.

Similar to marking editing changes with the `\edit` options there are also the `\authorcomments1{<text>}`, `\authorcomments2{<text>}` and `\authorcomments3{<text>}` commands. These produce the same bold red, italic blue and underlined purple text but when the `\turnoffediting` command is present the `<text>` material does not appear in the manuscript. Authors can use these commands to mark up text that they are not sure should appear in the final manuscript or as a way to communicate comments between co-authors when writing the article.

6. SOFTWARE AND THIRD PARTY DATA REPOSITORY CITATIONS

The AAS Journals would like to encourage authors to change software and third party data repository references from the current standard of a footnote to a first class citation in the bibliography. As a bibliographic citation these important references will be more easily captured and credit will be given to the appropriate people.

The first step to making this happen is to have the data or software in a long term repository that has made these items available via a persistent identifier like a Digital Object Identifier (DOI). A list of repositories that satisfy this criteria plus each one's pros and cons are given at https://github.com/AASJournals/Tutorials/tree/master/Repositories.

In the bibliography the format for data or code follows this format:

author year, title, version, publisher, prefix:identifier

? provides a example of how the citation in the article references the external code at https://doi.org/10.5281/zenodo.15991. Unfortunately, bibtex does not have specific bibtex entries for these types of references so the "@misc" type should be used. The Repository tutorial explains how to code the "@misc" type correctly. The most recent aasjournal.bst file, available with AASTeX v6, will output bibtex "@misc" type properly.

Facilities: HST(STIS), Swift(XRT and UVOT), AAVSO, CTIO:1.3m, CTIO:1.5m,CXO

Software: astropy (**??**), Cloudy (**?**), Source Extractor (**?**)

APPENDIX

A. APPENDIX INFORMATION

Appendices can be broken into separate sections just like in the main text. The only difference is that each appendix section is indexed by a letter (A, B, C, etc.) instead of a number. Likewise numbered equations have the section letter appended. Here is an equation as an example.

$$I = \frac{1}{1 + d_1^{P(1+d_2)}} \tag{A1}$$

Appendix tables and figures should not be numbered like equations. Instead they should continue the sequence from the main article body.

B. AUTHOR PUBLICATION CHARGES

Finally some information about the AAS Journal's publication charges. In April 2011 the traditional way of calculating author charges based on the number of printed pages was changed. The reason for the change was due to a recognition of the growing number of article items that could not be represented in print. Now author charges are determined by a number of digital "quanta". A single quantum is 350 words, one figure, one

table, and one enhanced digital item. For the latter this includes machine readable tables, figure sets, animations, and interactive figures. The current cost for the different quanta types is available at https://journals.aas.org/article-charges-and-copyright/#author_publication_charges. Authors may use the ApJL length calculator to get a `rough` estimate of the number of word and float quanta in their manuscript. The calculator is located at https://authortools.aas.org/ApJL/betacountwords.html.

C. ROTATING TABLES

The process of rotating tables into landscape mode is slightly different in AASTeXv6.31. Instead of the `\rotate` command, a new environment has been created to handle this task. To place a single page table in a landscape mode start the table portion with `\begin{rotatetable}` and end with `\end{rotatetable}`.

Tables that exceed a print page take a slightly different environment since both rotation and long table printing are required. In these cases start with `\begin{longrotatetable}` and end with `\end{longrotatetable}`. Table 1 is an example of a multi-page, rotated table. The `\movetabledown` command can be used to help center extremely wide, landscape tables. The command `\movetabledown=1in` will move any rotated table down 1 inch.

Table 1. Observable Characteristics of Galactic/Magellanic Cloud novae with X-ray observations

Name	V_{max}	Date	t_2	FWHM	E(B-V)	N_H	Period	D	Dust?	RN?
	(mag)	(JD)	(d)	(km s^{-1})	(mag)	(cm^{-2})	(d)	(kpc)		
CI Aql	8.83 (1)	2451665.5 (1)	32 (2)	2300 (3)	0.8±0.2 (4)	1.2e+22	0.62 (4)	6.25±5 (4)	N	Y
CSS081007	···	2454596.5	···	···	0.146	1.1e+21	1.77 (5)	4.45±1.95 (6)	···	···
GQ Mus	7.2 (7)	2445352.5 (7)	18 (7)	1000 (8)	0.45 (9)	3.8e+21	0.059375 (10)	4.8±1 (9)	N (7)	···
IM Nor	7.84 (11)	2452289 (2)	50 (2)	1150 (12)	0.8±0.2 (4)	8e+21	0.102 (13)	4.25±3.4 (4)	N	Y
KT Eri	5.42 (14)	2455150.17 (14)	6.6 (14)	3000 (15)	0.08 (15)	5.5e+20	···	6.5 (15)	N	M
LMC 1995	10.7 (16)	2449778.5 (16)	15±2 (17)	···	0.15 (203)	7.8e+20	···	50	···	···
LMC 2000	11.45 (18)	2451737.5 (18)	9±2 (19)	1700 (20)	0.15 (203)	7.8e+20	···	50	···	···
LMC 2005	11.5 (21)	2453700.5 (21)	63 (22)	900 (23)	0.15 (203)	1e+21	···	50	M (24)	···
LMC 2009a	10.6 (25)	2454867.5 (25)	4±1	3900 (25)	0.15 (203)	5.7e+20	1.19 (26)	50	N	Y
SMC 2005	10.4 (27)	2453588.5 (27)	···	3200 (28)	···	5e+20	···	61	···	···
QY Mus	8.1 (29)	2454739.90 (29)	60:	···	0.71 (30)	4.2e+21	···	···	M	···
RS Oph	4.5 (31)	2453779.44 (14)	7.9 (14)	3930 (31)	0.73 (32)	2.25e+21	456 (33)	1.6±0.3 (33)	N (34)	Y
U Sco	8.05 (35)	2455224.94 (35)	1.2 (36)	7600 (37)	0.2±0.1 (4)	1.2e+21	1.23056 (36)	12±2 (4)	N	Y
V1047 Cen	8.5 (38)	2453614.5 (39)	6 (40)	840 (38)	···	1.4e+22	···	···	···	···
V1065 Cen	8.2 (41)	2454123.5 (41)	11 (42)	2700 (43)	0.5±0.1 (42)	3.75e+21	···	9.05±2.8 (42)	Y (42)	···
V1187 Sco	7.4 (44)	2453220.5 (44)	7: (45)	3000 (44)	1.56 (44)	8.0e+21	···	4.9±0.5 (44)	N	···
V1188 Sco	8.7 (46)	2453577.5 (46)	7 (40)	1730 (47)	···	5.0e+21	···	7.5 (39)	···	···
V1213 Cen	8.53 (48)	2454959.5 (48)	11±2 (49)	2300 (50)	2.07 (30)	1.0e+22	···	···	···	···
V1280 Sco	3.79 (51)	2454147.65 (14)	21 (52)	640 (53)	0.36 (54)	1.6e+21	···	1.6±0.4 (54)	Y (54)	···
V1281 Sco	8.8 (55)	2454152.21 (55)	15:	1800 (56)	0.7 (57)	3.2e+21	···	···	N	···
V1309 Sco	7.1 (58)	2454714.5 (58)	23±2 (59)	670 (60)	1.2 (30)	4.0e+21	···	···	···	···
V1494 Aql	3.8 (61)	2451515.5 (61)	6.6±0.5 (61)	1200 (62)	0.6 (63)	3.6e+21	0.13467 (64)	1.6±0.1 (63)	N	···
V1663 Aql	10.5 (65)	2453531.5 (65)	17 (66)	1900 (67)	2: (68)	1.6e+22	···	8.9±3.6 (69)	N	···
V1974 Cyg	4.3 (70)	2448654.5 (70)	17 (71)	2000 (19)	0.36±0.04 (71)	2.7e+21	0.081263 (72)	1.8±0.1 (72)	N	···
V2361 Cyg	9.3 (73)	2453412.5 (73)	6 (40)	3200 (74)	1.2: (75)	7.0e+21	···	···	Y (40)	···
V2362 Cyg	7.8 (76)	2453831.5 (76)	9 (77)	1850 (78)	0.575±0.015 (79)	4.4e+21	0.06577 (80)	7.75±3 (77)	Y (81)	···
V2467 Cyg	6.7 (82)	2454176.27 (82)	7 (83)	950 (82)	1.5 (84)	1.4e+22	0.159 (85)	3.1±0.5 (86)	M (87)	···
V2468 Cyg	7.4 (88)	2454534.2 (88)	10:	1000 (88)	0.77 (89)	1.0e+22	0.242 (90)	···	N	···
V2491 Cyg	7.54 (91)	2454567.86 (91)	4.6 (92)	4860 (93)	0.43 (94)	4.7e+21	0.09580: (95)	10.5 (96)	N	M
V2487 Oph	9.5 (97)	2450979.5 (97)	6.3 (98)	10000 (98)	0.38±0.08 (98)	2.0e+21	···	27.5±3 (99)	N (100)	Y (101)
V2540 Oph	8.5 (102)	2452295.5 (102)	···	···	···	2.3e+21	0.284781 (103)	5.2±0.8 (103)	N	···
V2575 Oph	11.1 (104)	2453778.8 (104)	20:	560 (104)	1.4 (105)	3.3e+21	···	···	N (105)	···
V2576 Oph	9.2 (106)	2453832.5 (106)	8:	1470 (106)	0.25 (107)	2.6e+21	···	···	N	···
V2615 Oph	8.52 (108)	2454187.5 (108)	26.5 (108)	800 (109)	0.9 (108)	3.1e+21	···	3.7±0.2 (108)	Y (110)	···
V2670 Oph	9.9 (111)	2454613.11 (111)	15:	600 (112)	1.3: (113)	2.9e+21	···	···	N (114)	···
V2671 Oph	11.1 (115)	2454617.5 (115)	8:	1210 (116)	2.0 (117)	3.3e+21	···	···	M (117)	···

Table 1 (*continued*)

Name	V_{max}	Date	t_2	FWHM	E(B-V)	N_H	Period	D	Dust?	RN?
	(mag)	(JD)	(d)	(km s^{-1})	(mag)	(cm^{-2})	(d)	(kpc)		
V2672 Oph	10.0 (118)	2455060.02 (118)	2.3 (119)	8000 (118)	1.6±0.1 (119)	4.0e+21	···	19±2 (119)	···	M
V351 Pup	6.5 (120)	2448617.5 (120)	16 (121)	···	0.72±0.1 (122)	6.2e+21	0.1182 (123)	2.7±0.7 (122)	N	···
V382 Nor	8.9 (124)	2453447.5 (124)	12 (40)	1850 (23)	···	1.7e+22	···	···	···	···
V382 Vel	2.85 (125)	2451320.5 (125)	4.5 (126)	2400 (126)	0.05: (126)	3.4e+21	0.146126 (127)	1.68±0.3 (126)	N	···
V407 Cyg	6.8 (128)	2455266.314 (128)	5.9 (129)	2760 (129)	0.5±0.05 (130)	8.8e+21	15595 (131)	2.7 (131)	···	Y
V458 Vul	8.24 (132)	2454322.39 (132)	7 (133)	1750 (134)	0.6 (135)	3.6e+21	0.06812255 (136)	8.5±1.8 (133)	N (135)	···
V459 Vul	7.57 (137)	2454461.5 (137)	18 (138)	910 (139)	1.0 (140)	5.5e+21	···	3.65±1.35 (138)	Y (140)	···
V4633 Sgr	7.8 (141)	2450895.5 (141)	19±3 (142)	1700 (143)	0.21 (142)	1.4e+21	0.125576 (144)	8.9±2.5 (142)	N	···
V4643 Sgr	8.07 (145)	2451965.867 (145)	4.8 (146)	4700 (147)	1.67 (148)	1.4e+22	···	3 (148)	N	···
V4743 Sgr	5.0 (149)	2452537.5 (149)	9 (150)	2400 (149)	0.25 (151)	1.2e+21	0.281 (152)	3.9±0.3 (151)	N	···
V4745 Sgr	7.41 (153)	2452747.5 (153)	8.6 (154)	1600 (155)	0.1 (154)	9.0e+20	0.20782 (156)	14±5 (154)	···	···
V476 Sct	10.3 (157)	2453643.5 (157)	15 (158)	···	1.9 (158)	1.2e+22	···	4±1 (158)	M (159)	···
V477 Sct	9.8 (160)	2453655.5 (160)	3 (160)	2900 (161)	1.2: (162)	4e+21	···	···	M (163)	···
V5114 Sgr	8.38 (164)	2453081.5 (164)	11 (165)	2000 (23)	···	1.5e+21	···	7.7±0.7 (165)	N (166)	···
V5115 Sgr	7.7 (167)	2453459.5 (167)	7 (40)	1300 (168)	0.53 (169)	2.3e+21	···	···	N (169)	···
V5116 Sgr	8.15 (170)	2453556.91 (170)	6.5 (171)	970 (172)	0.25 (173)	1.5e+21	0.1238 (171)	11±3 (173)	N (174)	···
V5558 Sgr	6.53 (175)	2454291.5 (175)	125 (176)	1000 (177)	0.80 (178)	1.6e+22	···	1.3±0.3 (176)	N (179)	···
V5579 Sgr	5.56 (180)	2454579.62 (180)	7:	1500 (23)	1.2 (181)	3.3e+21	···	···	Y (181)	···
V5583 Sgr	7.43 (182)	2455051.07 (182)	5:	2300 (182)	0.39 (30)	2.0e+21	···	10.5	···	···
V574 Pup	6.93 (183)	2453332.22 (183)	13 (184)	2800 (184)	0.5±0.1	6.2e+21	···	6.5±1 (185)	M (185)	···
V597 Pup	7.0 (186)	2454418.75 (186)	3:	1800 (187)	0.3 (188)	5.0e+21	0.11119 (189)	···	N (188)	···
V598 Pup	3.46 (14)	2454257.79 (14)	9±1 (190)	···	0.16 (190)	1.4e+21	···	2.95±0.8 (190)	···	···
V679 Car	7.55 (191)	2454797.77 (191)	20:	···	···	1.3e+22	···	···	···	···
V723 Cas	7.1 (192)	2450069.0 (192)	263 (2)	600 (193)	0.5 (194)	2.35e+21	0.69 (195)	3.86±0.23 (196)	N	···
V838 Her	5 (197)	2448340.5 (197)	2 (198)	···	0.5±0.1 (198)	2.6e+21	0.2975 (199)	3±1 (198)	Y (200)	···
XMMSL1 J06	12 (201)	2453643.5 (202)	8±2 (202)	···	0.15 (203)	8.7e+20	···	50	···	···

A handy "cheat sheet" that provides the necessary LaTeX to produce 17 different types of tables is available at http://journals.aas.org/authors/aastex/aasguide.html#table_cheat_sheet.

D. IAU RECOMMENDATIONS FOR NOMINAL UNITS

The IAU 2015 resolution B3 defines nominal solar and planetary values by establishing conversions between solar and planetary values and SI units. The rational and specifications are given in **?**. The recommended nominal conversion constants for LaTeX have been incorporate into v6.31 to help authors follow the IAU resolution.

The general commands take this form:

Command	Example	Results
\nom{}	\nom{Q}	$\mathcal{Q}_\odot^{\mathbf{N}}$
\Eenom{}	\Eenom{Q}	$\mathcal{Q}_{Ee}^{\mathbf{N}}$
\Epnom{}	\Epnom{Q}	$\mathcal{Q}_{Ep}^{\mathbf{N}}$
\Jenom{}	\Jenom{Q}	$\mathcal{Q}_{Je}^{\mathbf{N}}$
\Jpnom{}	\Jpnom{Q}	$\mathcal{Q}_{Jp}^{\mathbf{N}}$

which can be used for any units the author requires. Examples of the most common uses would be:

1. \nom{(GM)} $(\mathcal{GM})_\odot^{\mathbf{N}}$ = nominal solar mass parameter
2. \nom{R} $\mathcal{R}_\odot^{\mathbf{N}}$ = nominal solar radius
3. \nom{S} $\mathcal{S}_\odot^{\mathbf{N}}$ = nominal total solar irradiance
4. \nom{L} $\mathcal{L}_\odot^{\mathbf{N}}$ = nominal solar luminosity

AASTeX v6.31 also contains specific commands for other commonly used units. These are:

1. \nomSolarEffTemp $\mathcal{T}_{\mathbf{eff}\odot}^{\mathbf{N}}$ = nominal solar effective temperature
2. \nomTerrEqRadius $\mathcal{R}_{Ee}^{\mathbf{N}}$ = nominal terrestrial equatorial radius
   \nomTerrPolarRadius $\mathcal{R}_{Ep}^{\mathbf{N}}$ = nominal terrestrial polar radius
   \nomTerrEqRadius $\mathcal{R}_{Ee}^{\mathbf{N}}$ should be used if equatorial vs. polar radius is not explicitly specified.
3. \nomJovianEqRadius $\mathcal{R}_{Je}^{\mathbf{N}}$ = nominal one-bar equatorial radii of Jupiter
   \nomJovianPolarRadius $\mathcal{R}_{Jp}^{\mathbf{N}}$ = nominal polar radii of Jupiter
   \nomJovianEqRadius $\mathcal{R}_{Je}^{\mathbf{N}}$ should be used if Jovian equatorial vs. polar radius is not explicitly specified.
4. \nomTerrMass $(\mathcal{GM})_{\mathbf{E}}^{\mathbf{N}}$ = nominal terrestrial mass parameter
   \nomJovianMass $(\mathcal{GM})_{\mathbf{J}}^{\mathbf{N}}$ = nominal Jovian mass parameter

All of these commands work equally well in text and math mode.

E. USING CHINESE, JAPANESE, AND KOREAN CHARACTERS

Authors have the option to include names in Chinese, Japanese, or Korean (CJK) characters in addition to the English name. The names will be displayed in parentheses after the English name. The way to do this in AASTeX is to use the CJK package available at https://ctan.org/pkg/cjk?lang=en. Further details on how to implement this and solutions for common problems, please go to https://journals.aas.org/nonroman/.