Things Good Astronomers Get Wrong in Their Papers

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In Order of Important → Trivial

- SIGNIFICANT FIGURES & ERROR BARS
- co-authors
- magnitudes are a unit
- hyphens, endashes, and minuses
- usage of ~ and \,
- rendering astronomical variables correctly
- footnotes and URLs
- sim versus approx?

I'm assuming that you are...

- using LaTeX
- using Bibtex (or some automated way to handle citations)
- using AAS package deluxetable
- using automatic Figure and Table numbering
- making decent figures (that would be another talk…)
- smart! Almost everything here is something *I* have screwed up myself at some point, so I'm not pretending like all of this is like "duh" stuff.

Significant Figures & Error Bars: Failure Mode #1

WRONG: 0.25 ± 0.1

3.1 ± 0.25

Significant Figures & Error Bars: Failure Mode #1

RIGHT: 0.25 ± 0.10 (or 0.25 ± 0.14 …)

3.10 ± 0.25 (or 3.14 ± 0.25 …)

Simple Rule: The number of decimal places on either side of the ± should always be the same.

Significant Figures & Error Bars: Failure Mode #2

NOT GREAT: 0.3 ± 0.1

Why? There are actually two reasons:

1) you probably know your error bar to better precision than this (i.e., "0.1" is consistent with everything from 0.095 to 0.144, even though 0.144 is >1.5x larger than 0.095!

2) *I* might need to know your error bar to better precision.

Significant Figures & Error Bars: Failure Mode #2

NOT GREAT: 0.31416 ± 0.09749

Why? This level of precision on the error is now silly.

"Error on the error"

Observers typically calculate error bars from the standard deviation (a.k.a. rms).

Since the rms is derived from data, it is not errorless! It too has an error...

$$\text{uncertainty in } \sigma \sim \sigma / \text{sqrt}(N)$$

N = number of samples

for the real answer, replete with Gamma functions:
http://mathworld.wolfram.com/StandardDeviationDistribution.html

"Error on the error"

"2.019 deg" implies ~0.001 deg error on the error → N ~ 4x10^6

Table 3
Keck/NIRC2 NRM Candidate Companions

$\Delta K'$ (mag)	ρ (mas)	PA (deg)
0.400 ± 0.062	28.548 ± 0.590	142.109 ± 2.019
3.706 ± 0.097	70.938 ± 1.596	196.658 ± 1.289
0.189 ± 0.091	16.940 ± 0.985 ← 3 sigfigs	233.485 ± 3.805
1.349 ± 0.022 ← 2 sigfigs	66.170 ± 0.335	316.688 ± 0.262
0.299 ± 0.231	16.089 ± 0.980	209.435 ± 4.706
4.749 ± 0.181	48.403 ± 3.276 ← 4 sigfigs	101.567 ± 3.121

"Error on the error"

100 ± 5 Jy   (5% error)

100.4612 ± 5.3247 Jy

5.3247 vs. 5.3250 → 0.006% different

There is no way you know your error bar to so much higher precision than the measurement itself.

Significant Figures & Error Bars: Recommendations

So what should you do?

1. Figure out how many significant figures you want to quote your error bar to. Personally, I tend to quote base values above **3** to just **one** sigfig (i.e., ±300 rather than ±310, or ±0.9 not ±0.89). Below this, I quote **two** sigfigs (i.e., ±110 not ±100, or ±0.12 not ±0.1). I round at **3**, but you could round at **2**.
2. Always make sure your corresponding measurement goes to the same decimal place, e.g., 8.7±0.9, 270±110. (NOT 8.75±0.9, 275±110)

Significant Figures & Error Bars: Recommendations

Table 1

Keck/NIRC2 Adaptive Optics Astrometry for LSPM J1314+1320A

Separation (mas)	PA (°)
66.2 ± 0.5	202.3 ± 0.5
54.0 ± 1.9	342 ± 7
78.62 ± 0.21	15.2 ± 0.6
88.1 ± 0.5	21.7 ± 0.5
137.25 ± 0.19	41.55 ± 0.04
153.16 ± 0.08	46.27 ± 0.03
166.43 ± 0.13	49.84 ± 0.05

Significant Figures & Error Bars

One more thing to keep in mind is how someone like me might end up using your quoted measurements and errors.

For example, distances in astronomy are often used to higher powers, so knowing the error precisely is important.

Luminosity ~ d^2, Mass ~ d^3

error in Luminosity ~ 2x error in distance

Which is why you should never round at 1!
±0.095x2 → ±0.190
±0.144x2 → ±0.288

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Get your co-authors names right.

Do they use initals for their middle name?

Do they use *only* initials? (Common practice among some of my more senior collaborators who are women.)

"mag" is a unit!

Wrong: K = 8.9 J-K = 1.0

Right: K = 8.9 mag J-K = 1.0 mag

"mag" is a unit!

Wrong: $z = 8.9$ this is a redshift

Right: $z = 8.9$ mag   this is photometry

"mag" is a unit! Just like dex...

Wrong: $\log(g)$ = 4.4

Right: $\log(g)$ = 4.4 dex

And ideally you indicate the units (e.g., "in cgs units").

Hyphens, Endashes, and Minuses

In LaTeX	Usage
`hypen: -`	joining words
`endash: --`	indicating a range
`minus: $-$`	subtraction

Hyphens, Endashes, and Minuses

In LaTeX	Correct Usage
hypen: -	`main-sequence star`
endash: --	`A--Z, $z=0.1$--0.6`
minus: $-$	`$J-K$, J1207$-$39`

Hyphens, Endashes, and Minuses

In LaTeX	Bad (or Sick) Usage!
hypen: -	`on the main-sequence`
endash: --	`A-Z, $z$=0.1-0.6`
minus: $-$	`$A-Z$, J1207-39`

Hyphens, Endashes, and Minuses

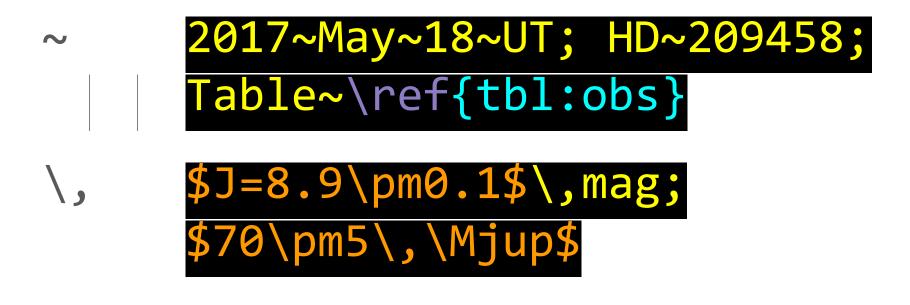We observed in J band.

Our J-band data were good.

Usage of ~ and \,

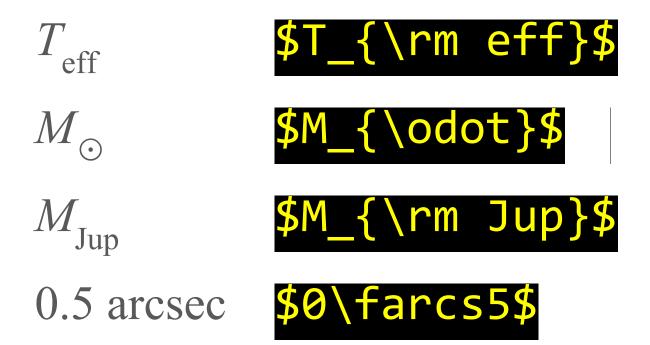Sometimes you want to make sure two bits of text stay next to each other.

~   single blank space

\,   bit less than one space (for units)

Usage of ~ and \,

Sometimes you want to make sure two bits of text stay next to each other.

~

```
2017~May~18~UT; HD~209458;
Table~\ref{tbl:obs}
```

\,

```
$J=8.9\pm0.1$\,mag;
$70\pm5\,\Mjup$
```

The Correct Way to Render Common Variables

$T_{\rm eff}$ `$T_{\rm eff}$`

$M_{\odot}$ `$M_{\odot}$`

$M_{\rm Jup}$ `$M_{\rm Jup}$`

0.5 arcsec   `$0\farcs5$`

The Correct Placement of Footnotes

… blah.[4]

[4]http:www.as.utexas.edu/~tdupuy

`blah.\footnote{\url{http:www.as.utexas.edu/~tdupuy}}`

And More! (From Brendan…)

	In LaTeX	Usage
~	$\sim$	order of magnitude estimate?
≈	$\approx$	more precise estimate but no real error bar?

And More! (From Brendan…)

-   CITE ORIGINAL LITERATURE (not just the latest summary and "references therein")

-   "e.g." means "for example" and nothing else

-   "i.e." means "that is" and nothing else

-   "cf." means "compare with" (and is rarely useful, I think)

-   you should spell out numbers less than 10