The Tromba Marina: a physical modelling case study (#superbadandpretentious)

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Put your abstract here. Abstracts are limited to 200 words for regular articles and 100 words for Letters to the Editor. Please no personal pronouns, also please do not use the words "new" and/or "novel" in the abstract. An article usually includes an abstract, a concise summary of the work covered at length in the main body of the article.

[XYZ]

Pages: 1–13

I. INTRODUCTION

A. History

The tromba marina is a monochord from **"insert country"** and created in ca. **"insert year"** (see 1). It was played mainly by women. The characteristic sound of the instrument comes from the rattling bridge, that makes the instrument sound like a trumpet rather than a bowed-string instrument.

Non-iterative collisions as presented in[?] ...

In[?] , the same authors have published a continuation with a focus on sonic output quality. To the best of the authors' knowledge, no other literature
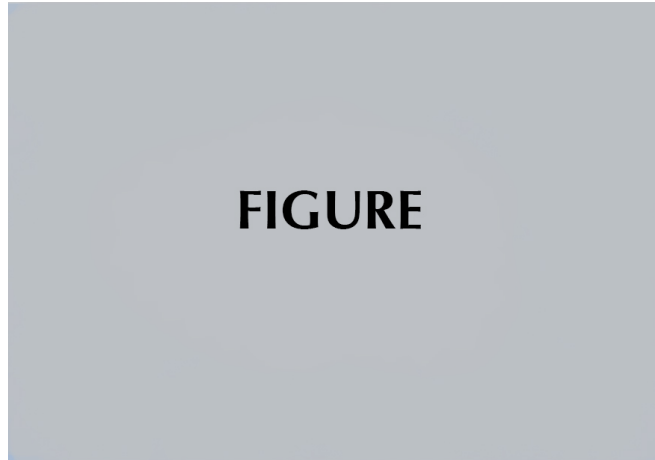

FIG. 1. The tromba marina.

II. INSTRUMENT DESIGN AND INTERACTION

The tromba marina is a chordophone... The interaction with the instrument is through bowing. The string rests on a rattling bridge, causing the The instrument rests with the neck on the shoulder of the player and the string is bowed close to the neck – as opposed to other bowed-string instruments which are bowed closer to the bridge. Different pitches are played by playing overtones or harmonics by placing a finger slightly on a one-over-integer multiple of the string length to create a node creating an overtone. ⇐ *Notes: need to find better wording.*

The instrument can be divided into three main components: the (bowed) string, the bridge and the body.

III. MODELS

In this section the model equations will be presented.

a. Notation. Subscripts 't' and 'x' denote a single derivative with respect to time or space. Furthermore, for clarity, subscripts 's' and 'p' will be given for parameter symbols that are shared between the string and the plate.

A. Damped Stiff String

Using state variable $u = u(x, t)$, the motion of a damped stiff string is described as

$$\rho_{\mathrm{s}} A u_{tt} = T u_{xx} - E_{\mathrm{s}} I u_{xxxx} - 2\rho_{\mathrm{s}} A \sigma_{0,\mathrm{s}} u_t + 2\rho_{\mathrm{s}} A \sigma_{1,\mathrm{s}} u_{txx}, \tag{1}$$

with material density ρ_{s} (kg·m^{-3}), cross-sectional area $A = \pi r^2$ (m^2), where r is the string radius (m), tension T (N), Young's modulus E_{s} (Pa), area moment of inertia $I = \pi r^4 / 4$ (m^4) and frequency independent and dependent loss factors $\sigma_{0,\mathrm{s}}$ (s^{-1}) and $\sigma_{1,\mathrm{s}}$ (m^2/s).

B. Bridge

The bridge is modelled as a damped mass with a linear restoring force. Its displacement $w = w(t)$ is de-

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scribed as

$$Mw_{tt} = -M\omega_0^2 w - MRw_t, \tag{2}$$

with bridge-mass M (kg), angular frequency ω_0 (s^{-1}) and damping coefficient R (s^{-1}). The restoring force has been added to simulate the fact that... It might seem odd have all terms include a multiplication with mass M, but as we start adding the effects of other parts of the system, it will make more sense.

C. Body

For simplicity, the body is modelled as a 2D plate. The displacement $v = v(x, y, t)$ at location (x, y) is described as

$$\rho_p H v_{tt} = -D\Delta\Delta v - 2\sigma_{0,p}v_t + 2\sigma_{1,p}\Delta v_t, \tag{3}$$

with material density ρ_p (kg·m^3), plate thickness H (m), $D = E_p H^3/12(1 - \nu^2)$ (kg·m^2·s^{-2}), where E_p is the Young's modulus (Pa) and ν the unitless Poisson's ratio, and and frequency independent and dependent loss factors $\sigma_{0,p}$ (s^{-1}) and $\sigma_{1,p}$ (m^2/s). Furthermore, Δ represents the 2D Laplacian and is defined as

$$\Delta = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2}. \tag{4}$$

D. Implementation

The complete system is shown in Eqs. (5a) – (5g).

$$
\begin{cases}
\rho_s A \delta_{tt} u_l^n & = T\delta_{xx}u_l^n - E_s I \delta_{xxxx}u_l^n \\
& \quad - 2\rho_s A\sigma_{0,s}\delta_{t\cdot}u_l^n \\
& \quad + 2\rho_s A\sigma_{1,s}\delta_{t-}\delta_{xx}u_l^n - J_s(l_{br})F_\alpha \tag{5a} \\
M\delta_{tt}w^n & = -M\omega_0^2 w^n - MR\delta_{t\cdot}w^n \\
& \quad + \left(\mu_{t+}\psi^{n-1/2}\right)g^n + F_\alpha \tag{5b} \\
\rho_p H \delta_{tt}v_{(l,m)}^n & = -D\delta_{\Delta\boxplus}\delta_{\Delta\boxplus}v_{(l,m)}^n - 2\sigma_{0,p}\delta_{t\cdot}v_{(l,m)}^n \\
& \quad + 2\sigma_{1,p}\delta_{t-}\delta_{\Delta\boxplus}v(l,m)^n \tag{5c} \\
& \quad - J_p(l_{br}, m_{br})\left(\mu_{t+}\psi^{n-1/2}\right)g^n \\
\delta_{t+}\psi^{n-1/2} & = g^n\delta_{t\cdot}\eta_c^n \tag{5d} \\
\eta_c^n & = v_{(l_{br},m_{br})}^n - w^n \tag{5e} \\
F_\alpha & = K_1\mu_{tt}\eta_{sp}^n + K_3(\eta_{sp}^n)^2\mu_{t\cdot}\eta_{sp}^n \\
& \quad + 2\sigma_\times\delta_{t\cdot}\eta_{sp}^n \tag{5f} \\
\eta_s^n & = u_{l_{br}}^n - w^n \tag{5g}
\end{cases}
$$

The time-difference operators have been chosen so that the system is most accurate but still explicit

IV. FLOATS, FIGURES AND TABLES

Figures and tables are typically "floats" which means that their final position is determined by LaTeX while the document is being typeset. LaTeX isn't always successful in placing floats optimally. Use the figure* environment to get a wide figure that spans the page in a two-column layout.

A. Tables

Tables generally should be surrounded with
\begin{ruledtabular}...\end{ruledtabular}
This will guarantee that they are the width of the page or column, and have two ruled lines at the top and bottom of the table.

[ht] in the code below instructs LaTeX to place the table where it appears in type, if it will fit on the page; otherwise put it on the top of the next page.

Footnotes in a table are labeled a, b, c, etc. They can be specified by using the LaTeX \footnotemark[] and \footnotetext[] commands. The footnotes for a table are typeset at the bottom of the table, rather than at the bottom of the page or at the end of the references. The arguments for \footnotemark[] and \footnotetext[] should be numbers 1, 2, ... The journal style will convert these to letters.

This system allows multiple entries to refer to the same footnote.

TABLE I. A table with more columns still fits properly in a column. Note that several entries share the same footnote. Inspect the LaTeX input for this table to see exactly how it is done.

	r_c (Å)[a]	r_0 (Å)	κr_0		r_c (Å)	r_0 (Å)	κr_0
Cu	0.800	14.10	2.550	Sn[a]	0.680	1.870	3.700
Ag	0.990	15.90	2.710	Pb[b]	0.450	1.930	3.760

[a] Here's the first.
[b] Here's the second.

B. Plain Tables: When NOT to use 'ruledtabular'

There are a number of cases when 'ruledtablar' should not be used: basically for any table using complex content or commands.

1. Using `\multicolumn`

When you'd like to use the multicolumn command in your table, you'll find that 'ruledtabular' will cause bad formatting. In that case, Don't Use Ruledtabular, and instead put in `\hline\hline` at the top and bottom of the table.

TABLE II. A table made without 'ruledtabular' needs to have two hlines added to the top and bottom of the table.

	r_c (Å)[a]	r_0 (Å)	κr_0		r_c (Å)	r_0 (Å)	κr_0
Cu	0.800	14.10	2.550	Sn[a]	0.680	1.870	3.700
Ag	0.990	15.90	2.710	Pb[b]	0.450	1.930	3.760
Au	1.150	15.90	2.710	Ca[c]	0.750	2.170	3.560

[a] This is the first table note.
[b] This is the second table note.
[c] This is the third table note.

2. Using the `\adjustbox{}` `(tabular)\end{adjustbox}` command

There may be times when the table is too wide, or you want to have the table be the width of the page, whether or not it appears in preprint or reprint version of JASAnew. In this case you can use `\begin{adjustbox}{<width>} (tabular) \end{adjustbox}`. ('adjustbox' will NOT work with 'ruledtabular')

You can set a maximum width with `\begin{adjustbox}{max width=\textwidth}(tabular)\end{adju`
in which case the table in the reprint version might be less than the full text width;

Or you can set the exact width you'd like with `\begin{adjustbox}{width=\textwidth}(tabular)\end{adjustbo`
in which case the table will be the full width of the page in either preprint or reprint.

This way you can make a table that will fit in the correct width whether you are using the preprint or reprint option.

TABLE III. Top 5 rated $\widehat{\text{ITD}}$ estimation methods according to the sum and product metric criteria for ± 0.5 JND and ± 1 JND tolerance thresholds (normalized scores).

Rank #	sum criteria [± 0.5 JND]	sum criteria [± 1 JND]	product criteria [± 0.5 JND]	product criteria [± 1 JND]
1	Threshold –30dB lp (0.43)	Threshold –30dB lp (0.71)	Threshold –30dB lp (1.00)	Threshold –30dB lp (1.00)
2	MaxIACCe lp (0.39)	Threshold –20dB lp (0.66)	MaxIACCe lp (0.39)	Threshold –20dB lp (0.57)
3	Threshold –20dB lp (0.38)	CenIACCr bb (0.62)	CenIACCr lp (0.33)	CenIACCr bb (0.37)
4	CenIACCr lp (0.37)	MaxIACCe lp (0.61)	Threshold –20dB lp (0.29)	MaxIACCe lp (0.34)
5	Cen-e^2 lp (0.34)	CenIACCe lp (0.61)	Cen-e^2 lp (0.10)	CenIACCr lp (0.33)

C. Using dcolumn

\usepackage{dcolumn} is included in JASAnew.cls so you don't need to add it explicitly. http://anorien.csc.warwick.ac.uk/mirrors/CTAN/macros/latex/required/tools/dcolumn.pdf will give you detailed information. A gentler introduction may be found in this informative and well illustrated article: https://www.tug.org/pracjourn/2007-1/mori/mori.pdf, starting on page 20. (You may want to look at more examples in this quite comprehensive article on making tables in LaTeX.)

"If we do not want to break the fractional and the integral part in two columns, the dcolumn package provides a new type of column D{sep -in}{sep -out}{ before.after} The first argument {sep-in} is the symbol used in the .tex document to separate the integral and the fractional part (usually the decimal point . or the decimal comma ,), the second argument {sep-out} is the symbol that we want in the output, the third is the number of digits on the left (before) and on the right (after) this symbol. The numbers are aligned to the decimal point and, in case that the third argument is negative, the decimal point is aligned to the center of the column. If the columns have a heading, it must be inserted into the command \multicolumn{1}{c}{...}

An example using dcolumn:

```
{\hsize= 2in
\begin{ruledtabular}
\begin{tabular}{cD {,}{.}{5.4}}
Expression          & \multicolumn {1}{c}{ Value }\\
\hline
$\pi$               &        3,1416                \\
$\pi^{\pi}$         &        36,46                 \\
$\pi^{\pi^{\pi}}$   & & 80662,7                    \\
\end{tabular}
\end{ruledtabular}
}
```

Expression	Value
π	3.1416
π^{π}	36.46
$\pi^{\pi^{\pi}}$	80662.7

D. Sample Figures, new commands available in this style

Note that the publisher determines the final layout, so your choice of figure alignment may not be reflected in the published article.

\figline{} will center one or more figures on one line.

\fig{<name of file>}{<width>}{<letter to put underneath>}

\leftfig{<name of file>}{<width>}{<letter to put underneath>}

\rightfig{<name of file>}{<width>}{<letter to put underneath>}

\boxedfig{<name of file>}{<width>}{<letter to put underneath>}

\rotatefig{<degrees of rotation>}{<name of file>}{<width>}
{<letter to put underneath>}

The following illustrations show these commands in use.

```
\figline{\fig{figsamp.jpg}{4cm}{(a)}
\fig{figsamp.jpg}{4cm}{(b)}}
\figline{\fig{figsamp.jpg}{4cm}{(c)}
\fig{figsamp.jpg}{4cm}{(d)}}
\figline{\fig{figsamp.jpg}{4cm}{(e)}}
```
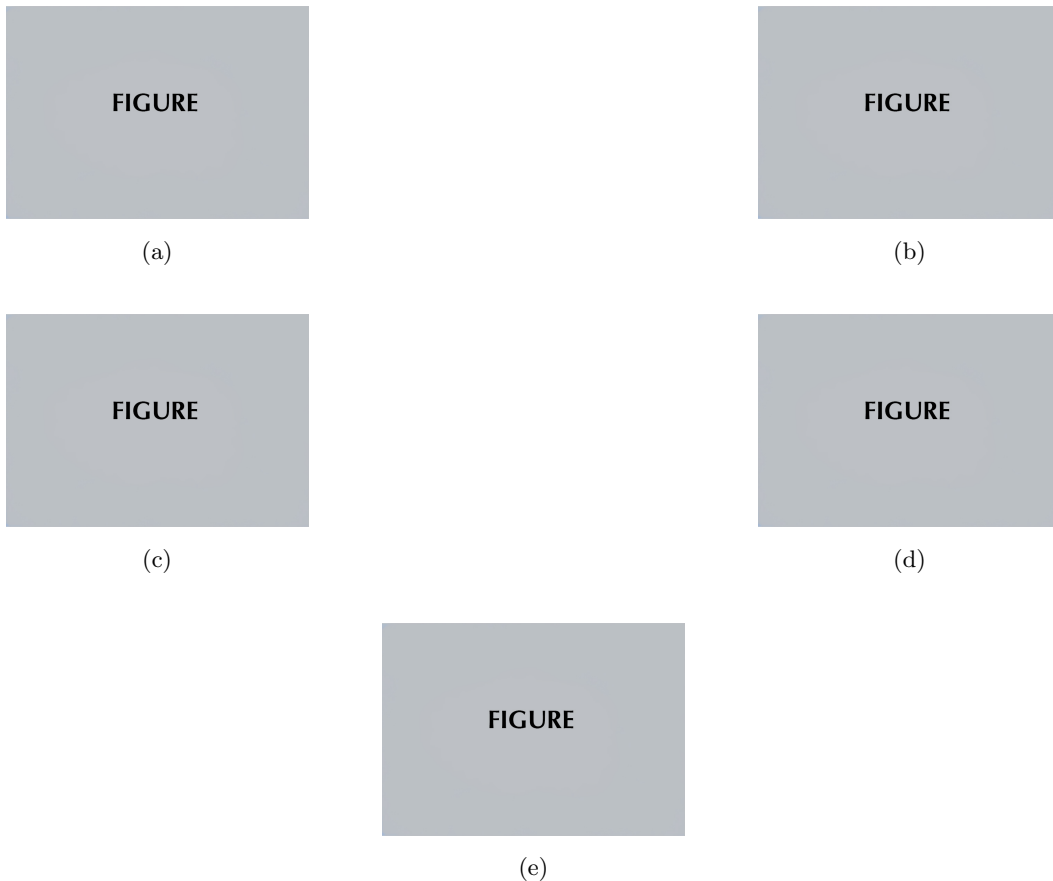
FIGURE

(a)

FIGURE

(b)

FIGURE

(c)

FIGURE

(d)

FIGURE

(e)

FIG. 2.   Multiple images on one figure example (a) image 1, (b-f) (ρ=1000 kg/m^3) and speed of sound (c=1500 m/s).

```
\figline{\boxedfig{figsamp.jpg}{2in}{(a)}}
\figline{\leftfig{figsamp.jpg}{2in}{(b)}\rightfig{figsamp.jpg}{2in}{(c)}}
\figline{\rotatefig{90}{figsamp.jpg}{2in}{(d)}\rotatefig{180}{figsamp.jpg}{2in}{(e)}}
```
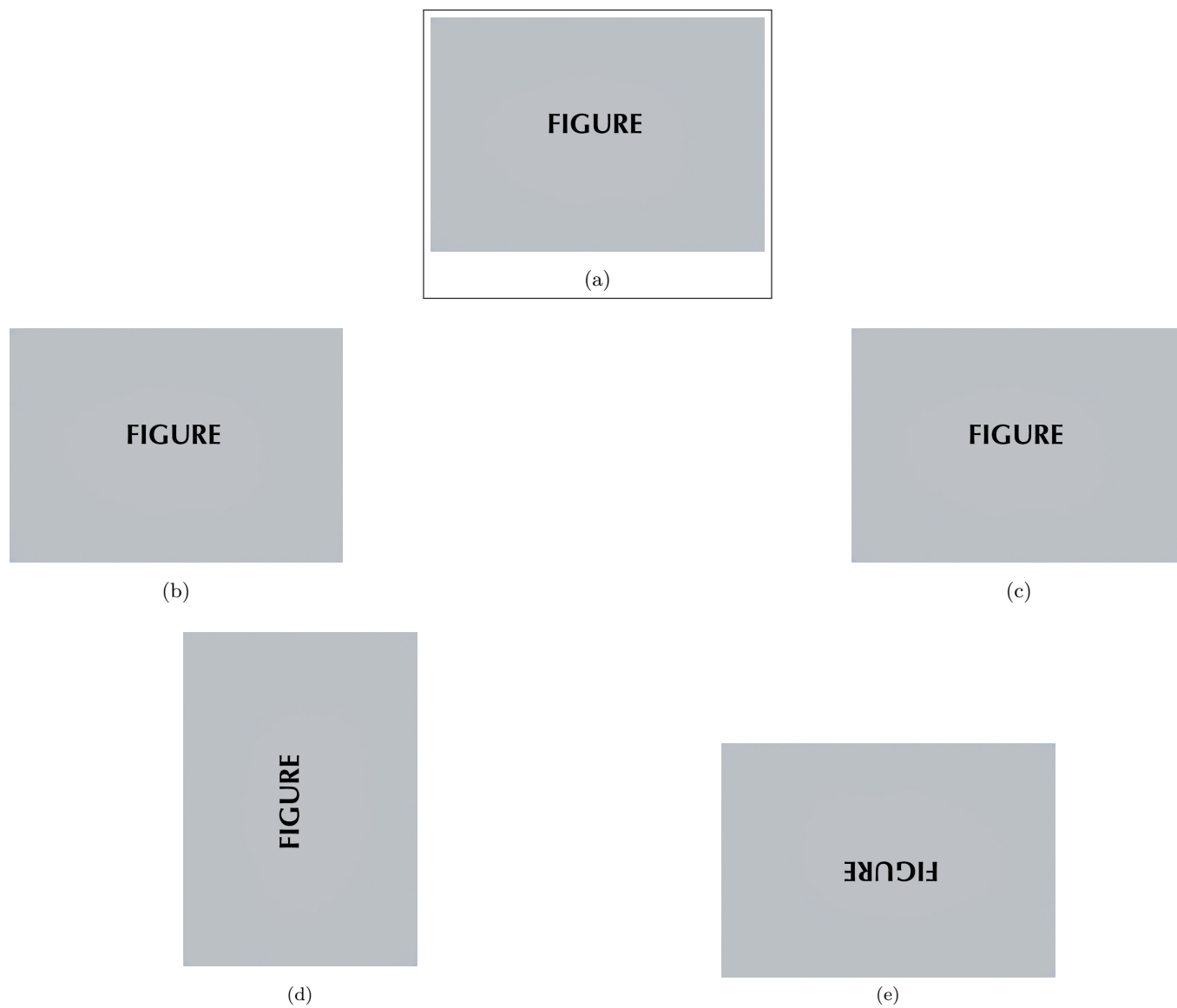

FIG. 3. More figure examples: (a) boxedfig, (b)leftfig; (c)right fig; (d) rotatefig 90 degrees; (e) rotatefig 180 degrees.

```
\sidebysidefigures{figsamp.jpg}{Describing the first
illustration.}/{figsamp.jpg}{Describing the second illustration.}
```

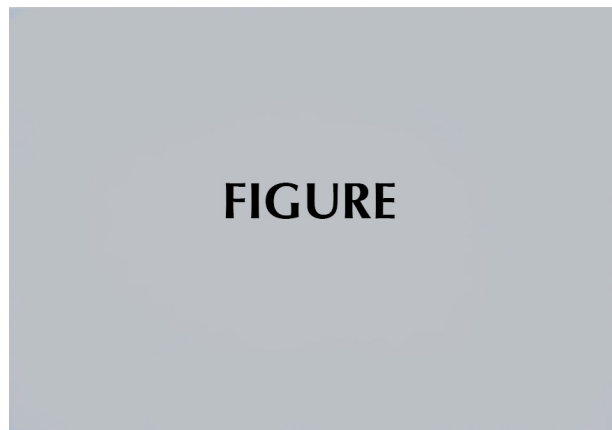FIG. 4. Describing the first illustration.

FIG. 5. Describing the first illustration.

```
\figline{
\fig{figsamp.jpg}{.7\textwidth}{}
\narrowcaption{.2\textwidth}{Here is a narrow caption.}
}
```
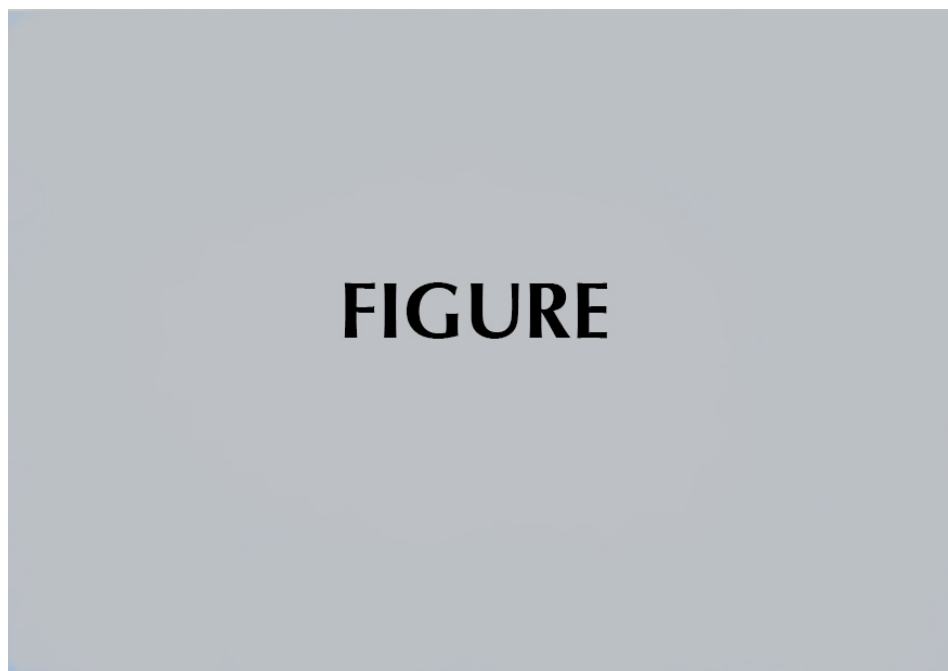
FIG. 6. Here is a narrow caption.

```
\figline{\fig{figsamp.jpg}{.2\textwidth}{(A)}
\fig{figsamp.jpg}{.2\textwidth}{(B)}
\fig{figsamp.jpg}{.2\textwidth}{(C)}
\narrowcaption{.25\textwidth}{Caption for three illustrations.
The caption may produce many lines, but only one paragraph.
}}
```
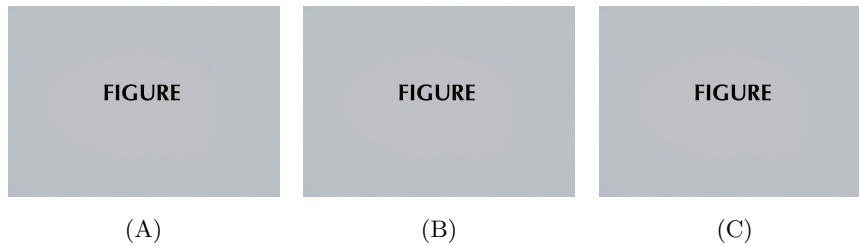

(A)   (B)   (C)

FIG. 7. Caption for three illustrations. The caption may produce many lines, but only one paragraph.

```
\figline{\fig{figsamp.jpg}{.7\textwidth}{}
\narrowcaption{.25\textwidth}{Here is a narrow caption that will can be
positioned to the right of four illustrations.
You cannot have more than one paragraph of text in a caption.
You cannot have more than one paragraph of text in a caption.
You cannot have more than one paragraph of text in a caption.
You cannot have more than one paragraph of text in a caption.
}}
```
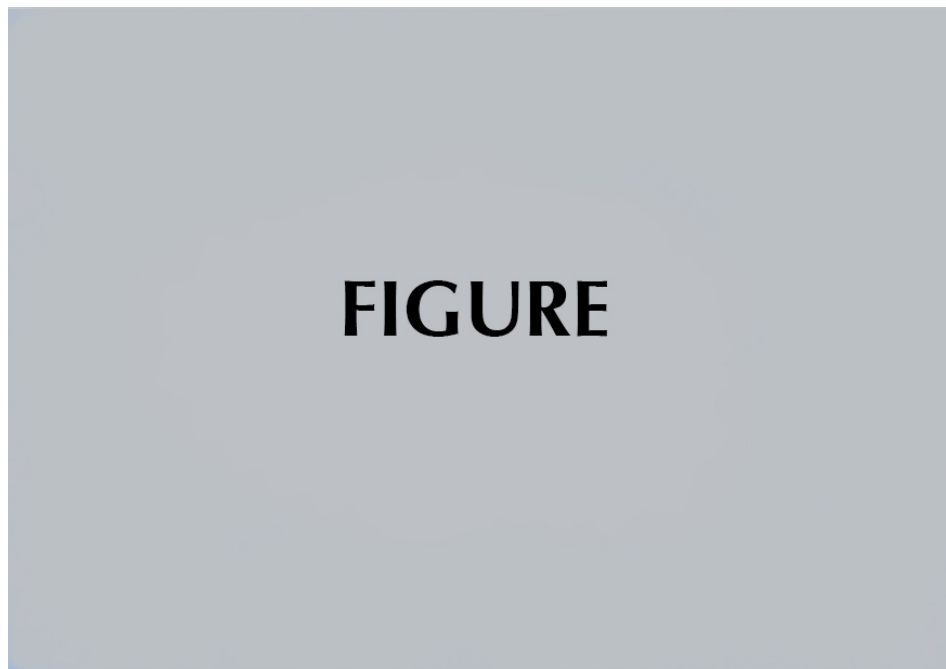

FIG. 8. Here is a narrow caption that will can be positioned to the right of four illustrations. You cannot have more than one paragraph of text in a caption. You cannot have more than one paragraph of text in a caption. You cannot have more than one paragraph of text in a caption. You cannot have more than one paragraph of text in a caption.

```
\figcolumn{
\fig{figsamp.jpg}{.2\textwidth}{(A)}
\fig{figsamp.jpg}{.2\textwidth}{(B)}
\fig{figsamp.jpg}{.2\textwidth}{(C)}
}
```
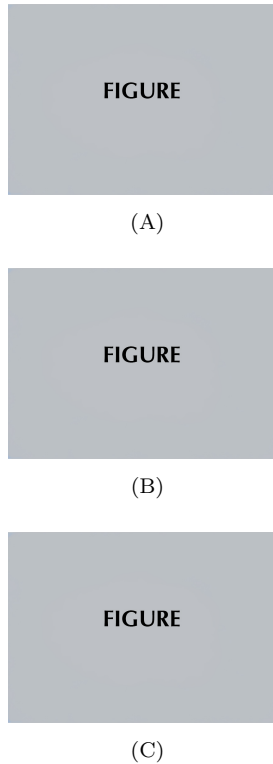

(A)

(B)

(C)

FIG. 9. Here are some stacking figures in a single column. The `\figcolumn{}` command works equally well in single or double column figures.

E. Example of multimedia entry

Please note that this is for multimedia intended to appear inline within the published article.

Here is what a multimedia entry will look like:

Mm. 1. Corresponding pulse-compressed echo envelopes and video recordings from a fluttering luna moth. Echoes from the wings and body of the moth generally dominate the acoustic returns, which vary greatly over consecutive ensonifications across the wingbeat cycle. File of type "mp4" (15.3 MB)

Here we try cross referencing the multimedia entry: The multimedia above is Mm. 1.

F. Supplementary Material

ASA prefers that authors to submit related/relevant article files as supplementary material with their submission.

G. Supplementary material for publication

Any archival supplemental materials to be published with the manuscript (eg., supplementary figures) should be cited in-text and a footnote provided.

An example of reference to supplementary material:

The sound files and videos for this and other figures are included as supplementary materials[1].

The contents of the footnote above will appear at the beginning of the bibliography made with BibTeX when the default 'author-year' documentclass option is used; BibTeX output will have the footnote interleaved with other references if the NumberedRefs documentclass option is used.

H. File naming conventions

Here are the conventions for naming files:

- Supplementary Figure or Supplementary Figure or Text files should be named: SuppPub#.xxx, where "#" is a number and "xxx" is the file format extension (SuppPub1.docx, SuppPub2.jpg, etc)

- Supplementary Multimedia files: SuppPubmm#.xxx, where "#" is a number and "xxx" is the file format extension (SuppPubmm1.mp3, SuppPubmm2.gif, etc)

- Multimedia files must be named accordingly: MM#.xxx, where "#" is the number and "xxx" is the file format extension (MM1.wav, MM2.avi, etc).

- The only figure formats allowed are the following: .pdf, .ps, .eps, or .jpg. Figure files must be named in this fashion: Figure#.xxx, where "#" is the figure number and "xxx" is the file format (Figure1.eps, Figure2.jpg, Figure3a.ps, Figure3b.ps, etc).

V. CONCLUSION

And in conclusion. . .

ACKNOWLEDGMENTS

This research was supported by ...

APPENDIX A: APPENDICES

To start the appendix, use the `\appendix` command. This signals that all following section commands refer to

appendixes instead of regular sections. Therefore, the `\appendix` command should be used only once—to set up the section commands to act as appendices. Thereafter normal section commands are used. The heading for a section can be left empty. For example,

```
\appendix
\section{}
```

will produce an appendix heading that says "APPENDIX A" and

```
\appendix
\section{Background}
```

will produce an appendix heading that says "APPENDIX A: BACKGROUND" (note that the colon is set automatically).

If there is only one appendix, then the letter "A" should not appear. This is suppressed by using the star version of the appendix command (`\appendix*` in the place of `\appendix`).

APPENDIX B: A LITTLE MORE ON APPENDICES

Observe that this appendix was started by using

```
\section{A little more on appendixes}
```

Note the equation number in an appendix:

$$E = mc^2. \tag{B1}$$

1. A subsection in an appendix

You can use a subsection or subsubsection in an appendix. Note the numbering: we are now in Appendix B 1.

a. A subsubsection in an appendix

Note the equation numbers in this appendix, produced with the subequations environment:

$$E = mc, \tag{B2a}$$
$$E = mc^2, \tag{B2b}$$
$$E \gtrsim mc^3. \tag{B2c}$$

They turn out to be Eqs. (B2a), (B2b), and (B2c).

APPENDIX C: SAMPLE APPENDIX FIGURE AND TABLE

Figure and table numbering are continuous through the article, and handled the same as they are in the rest of the article.

FIG. 10. Figure in an appendix.

TABLE IV. Here is the caption for a table in an appendix.

one	two	three	four
C	D	E	F

1. Footnotes

The contents of the footnotes will appear at the beginning of the bibliography when BibTeX produces the .bbl file using the default AuthorYear style; interleaved with other references if NumberedRefs option:
`\documentclass[preprint,NumberedRefs]{JASAnew}`
and BibTeX has been used.

This example show where this cite[2] will appear in the bibliography, depending on whether we use default author-year style or call for the NumberedRefs documentclass option.

Here are some sample footnotes:[3,4]

APPENDIX D: MAKING THE BIBLIOGRAPHY USING BIBTEX

Authors are highly recommended to use BibTeX to produce their bibliographies. The results will be predictable and even if it might take some time to get comfortable with using BibTeX, in the long run it will save you endless aggravation.

A resource for making your bibliography entries correctly is included in this package: JASA-ReferenceStyles.pdf. You will also find the files bibsamp1.tex/.pdf and bibsamp2.tex/.pdf for examples of output; and sampbib.bib for an example of how to make your .bib database entries.

There are two possible bibliography styles: the default, author-year, and the optional style, NumberedRefs, which you would call using
`\documentclass[preprint,NumberedRefs]{JASAnew}`

Every `\cite` will produce a citation and an entry in the bibliography and every cite must have a matching entry in the bib database file.

`\citep{}` should be used rather than `\cite{}` Note that the citations are hyperlinked to their entries in the bibliography:

Normal journal cite:[5], Book reference[2], In press,[6]. Computer language documentation:[7].

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JASA/Sample JASA Article

NOTE:

Once you have used BibTeX you should open the resulting .bbl file and cut and paste the entire contents into the end of your article. You should also comment out `\bibliography{<your .bib file>}`*, ie,* `%\bibliography{<your .bib file>}`*.*

Make your bibliography by doing: pdflatex filename, bibtex filename, pdflatex filename, pdflatex filename.

Compare the results you get with
`\documentclass[preprint]{JASAnew}`
vs.
`\documentclass[preprint,NumberedRefs]{JASAnew}`

---

[1]See Supplementary materials at [URL will be inserted by AIP] for [give a brief description of the material].

[2]J. P. Hollman, *Heat Transfer*, 8th ed. (McGraw-Hill, New York, 1997), p. 55.

[3]Here is the second footnote. It will appear before the beginning of the bibliography in Author-Year style (default) or it will be interleaved with other references when using the NumberedRefs option.

[4]Here is a third footnote.

[5]R. S. Christian, R. E. Davies, A. B. Tubis, and C. A. Anderson, "Effects of air loading on tympani membrane vibrations," J. Acoust. Soc. Am. **76**, 1336–1345 (1984).

[6]A. Tolstoy, "Using low frequencies for geoacoustic inversion," in *Theoretical and Computational Acoustics 2010*, Dresden, Germany,(in press).

[7]DISPERSE, "A system for generating dispersion curves," User's Manual Version 2.0.16d (2001), doi: 10.1177/1045389X16667559.