SHOCK WAVES

An International Journal on Shock Waves, Detonations and Explosions

Checklist for Manuscript Preparation

A guide to preparing scientific papers for submission to the Shock Waves journal

Shock Waves Editorial Board
Version 1.0.1
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Part I. General matters

Aims and scope of the journal

The scope of *Shock Waves* is defined on the journal website as follows:

> *Shock Waves* provides a forum for presenting and discussing new results in all fields where shock and detonation phenomena play a role. The journal addresses physicists, engineers, and applied mathematicians working on theoretical, experimental, or numerical issues, including diagnostics and flow visualization. Coverage includes, among other topics, aero- and gas dynamics, acoustics, physical chemistry, condensed matter, and plasmas, with applications encompassing materials sciences, space sciences, geosciences, life sciences, and medicine. Of particular interest are articles which provide insights into fundamental aspects of the techniques that are relevant to more than one specific research community. [1]

Note that, "articles which provide insights into fundamental aspects of the techniques that are relevant to more than one specific research community," implies that submissions should strive to make a contribution to the entire field of shock wave research, not just address a particular problem or specific application.

Archival paper requirements

A submission to an archival journal should be the result of years of careful research in which results were thoroughly verified. The paper that reports the results should reflect similar care and diligence in the preparation of the manuscript. The ability of the authors to prepare a quality manuscript adhering to the standards of the journal is viewed by the Editorial Board as a reflection of the authors' ability to perform their research in a consistent and error-free manner. In addition to this checklist, additional helpful resources that authors may wish to consult in preparing a journal submission are listed in Refs. [2, 3, 4].

Before preparing a manuscript for submission to *Shock Waves*, authors should answer the following questions:

- ☐ Is the manuscript an original contribution? All text and figures should be original content generated by the authors themselves.[1]
- ☐ Is the study novel? Does the manuscript address a problem that has not been previously considered in the literature?
- ☐ Is the study of fundamental interest to the entire *Shock Waves* community? Are the results going to be used by the community?
- ☐ Is the study an archival contribution? Is the manuscript a complete, definitive treatment of a problem, as opposed to a progress report that will be updated in coming years with additional results?

Technical note

If a study does not meet all of the above criteria, a manuscript may still be considered for publication as a Technical Note (four pages maximum) if it meets one of the following criteria:

- ☐ If the manuscript reports the development of novel experimental hardware or technique, without significant analysis or results.
- ☐ A theoretical study of limited scope, e.g., derivation of a useful analytic relation.
- ☐ If the manuscript reports a preliminary result of a breakthrough nature that should be rapidly communicated to the community.

[1] Selective reprinting of earlier results is permissible, but direct reproduction of figures requires permission of the original publisher, even if the results are from the authors' own studies.

Numerical studies

If the study is numerical in nature, e.g., using computational fluid dynamics (CFD), finite-element methods (FEM), etc., it must contain **one or more** of the following elements:

- ☐ Are numerical simulations validated by experimental data or used to reproduce and interpret experimental results?
- ☐ Does the numerical implementation contain an innovation in terms of numerical scheme or algorithm development?
- ☐ Is the numerical method validated by an analytic solution or used to develop or validate an analytic solution?

Studies using commercial software (ANSYS Fluent, Autodyn, DYNA, etc.) or open-source software (e.g., OpenFOAM and its derivatives, etc.) are generally not considered for publication unless they fit into one of these categories:

- The use of software is part of a larger investigation incorporating experiments or a significant development of a new analytic theory.
- The paper reports a significant contribution to the development of the software. For example, a paper that reports the details of implementing and validating a new method or solver with OpenFOAM or commercial software would be acceptable for consideration.

Studies that consist of exclusively performing simulations using commercial or open-source software without proper validation will not be considered for publication.

Manuscript preparation

Authors are strongly suggested to submit their manuscripts in TEX format using the *Shock Waves* template. If a manuscript is accepted, the production of the article will be done in TEX, and equations that are not prepared in TEX will be typeset by hand by the Springer Production staff, greatly increasing the likelihood that errors will be introduced in the equations. By submitting the manuscript in TEX, the authors' formulation of their equations and mathematical notation can be used directly, reducing the likelihood for introduction of errors.

While use of TEX is highly encouraged, most TEX editors have primitive spelling and grammatical checkers in comparison to word processors (e.g., MS Word, Google Docs, etc.). Therefore, even if using TEX, authors are encouraged to either initially write their text in Word or another word processor and then spelling and grammar check before pasting the text into TEX, or export a document from TEX or PDF that can be spelling and grammar checked in MS Word, etc.

- ☐ If the paper contains a large amount of mathematical notation (e.g., on the order of 10 equations or more), TEX is strongly recommended to be used for manuscript submission.
- ☐ If the manuscript is prepared in TEX, the authors must be able to perform a software-based spelling and grammar check.

Submission information

Author information

- ☐ Authors should be people who were essential to the study and manuscript preparation. I.e., an individual should only be included as an author if the study *could not have been completed without their involvement.*
- ☐ Individuals who assisted in the study but did not make essential contributions can be listed in the Acknowledgments.

☐ Authors should not be added to a paper once it is submitted.[2] Assisting in proofreading the manuscript, for example, does not justify inclusion as an author.

☐ The affiliation(s) and address(es) of all author(s) should be provided.

☐ Telephone number(s) of the corresponding author should be provided.

☐ Authors should provide their Open Researcher and Contributor ID (ORCID) number. An ORCID can be obtained from https://orcid.org/. If the submitted paper is published, the authors' unique ORCID would appear as a hyperlink next to the names of authors of the paper, enabling readers to easily find their other publications and current affiliation via a stable link (similar to a DOI number for a paper). This system will increasingly be used in the future to uniquely identify researchers and will eventually become mandatory.[5]

Suggested reviewers

Authors are encouraged to submit suggested reviewers in order to assist the editor in finding qualified experts who can provide an independent assessment of the submission. These suggestions may or may not be used; an editor will typically not use all of the suggested reviewers.

☐ Suggested reviewers must be recognized experts in the field.

☐ Suggested reviewers must be from separate institutions from the authors and geographically separated (preferably, from a different country).

☐ Suggested reviewers should not have previously published papers with any of the authors or participated in other collaborations with the authors in the previous 10 years.

☐ Authors should suggest reviewers that can assess different aspects of the work. E.g., a numerical study on shock-induced boundary layer separation in a supersonic inlet should be examined by:

- An expert on the numerical methods used
- An expert on shock–boundary layer interactions
- An expert on supersonic inlets

☐ Provide complete contact information for suggested reviewers.

☐ Suggested reviewers must have institutional e-mail addresses. The only exception would be if a suggested reviewer is a recognized expert and is now retired, then will non-institution e-mail addresses (e.g., outlook.com, gmail.com, yeah.net, 163.com, etc.) be considered valid.

[2] Addition of an author after submission requires that a **Change of authorship request form**, signed by all authors, be submitted and reviewed by the Editorial Board for approval. Unless a valid reason as to why the proposed new author was essential to completion of the paper is provided, the request will be denied.

Part II. Structure of manuscript

Authors are suggested to follow the structure outlined here in preparing their manuscript.

Abstract

The abstract should provide a summary of the paper, including the main findings. Note that abstracts are available via database searches and appear outside the paywall of the publisher's website. Thus, the abstract may be the only information available to perspective readers, and thus the abstract should be able to inform readers if they want to order the entire paper. An excellent guide to preparing an abstract can be found in [6].

- ☐ The abstract should be between approximately 150 to 250 words.
- ☐ The abstract should be a single paragraph without line breaks.
- ☐ The abstract should be a summary of the work done by the authors. The abstract is **not** an introduction.
- ☐ References should be avoided in the abstract, but if absolutely necessary, should appear as follows:

  > The present study builds on the earlier work of Toro et al. (Shock Waves **4**:25-34, 1994).

  Note DOI number does not appear and there is no reference number. The same paper must be referenced again (with a reference number and DOI number appearing in the reference list), preferably early in the Introduction.
- ☐ Avoid abbreviations, acronyms, and specialized terminology in the abstract.
- ☐ Avoid excessive amounts of mathematical notation in the abstract.
- ☐ Does the abstract present the main findings or conclusion of the study?
- ☐ From the information in the abstract alone, can a potential reader decide if they want to read the entire paper?

List of symbols and nomenclature

Papers with a great amount of notation or abbreviations should consider having a list of symbols or nomenclature section. If a symbol or abbreviation is defined in this section, it does **not** need to be defined in the main text. This section should be organized as follows:

- Latin symbols in alphabetical order
- Greek symbols in alphabetical order
- Subscripts and superscripts in alphabetical order (Latin then Greek)
- Abbreviations in alphabetical order

- ☐ If the paper has a list of symbols or nomenclature section, is it organized as specified above?

1 Introduction

The Introduction must define the problem that will be addressed in the rest of the paper, placing it in context with the existing literature on the problem. The first paragraph should introduce the specific topic to the target audience of the *Shock Waves* community; while the readership can be assumed to have a basic knowledge of shock waves and compressible flow, they may not have expertise on the specific topic of study. A schematic figure is a very effective way to communicate the problem being studied. The introduction should **not** be a history lesson, i.e., it is not necessary to trace the history of shock waves back to Ernst Mach, etc. The literature review should be thorough but does not need to be exhaustive; it is better to cite and critically discuss the few, keys studies that are most relevant to the present study, rather than simply cite large numbers of papers that are only peripherally related to the current study. Statements such as, "Prior studies that considered this problem include [37–48]," are not acceptable; each reference should be presented and discussed as it relates to the present study.

The Introduction must clearly identify the problem being studied as novel and addressing a gap in the existing literature. The Introduction should conclude with outlining the plan for addressing or solving this problem that will be detailed in the rest of the paper. This plan should **not** include results, discussion, or conclusions—only the plan of what will be presented. The total length of the Introduction should not usually exceed two pages (when formatted for journal publication), as readers may become impatient to see what novel contributions the present paper is going to make. A longer Introduction is justified for review-style papers.

- ☐ Does the Introduction present the problem in a way to interest the entire *Shock Waves* community?
- ☐ Does the Introduction critically review the relevant literature?
- ☐ Is the original source of key concepts cited, not just a review paper, textbook, or more recent papers?
- ☐ Is the relevance of the cited literature to the present study discussed? I.e., papers should not just be listed, but rather presented in terms of how they relate to the problem being studied.
- ☐ Is the literature review up to date, particularly for manuscripts that derive from earlier conference papers?
- ☐ Does the Introduction conclude with an identification of a problem that has not been previously considered in the literature?
- ☐ If the present study is a follow-up to an earlier publication by the same authors, the relation between the earlier study and the present manuscript should be made explicit. [3]
- ☐ Does the Introduction have a figure (usually, Fig. 1 in the paper) presenting a graphical presentation of the problem (e.g., schematic, rendering, photograph, etc.)?
- ☐ Does the Introduction conclude by presenting how the present study will address the outstanding problem? The Introduction should only introduce the approach that will be developed in the rest of the paper; the Introduction should **not** present results or conclusions.
- ☐ Is the Introduction less than approximately two pages when formatted for journal publication, unless a longer Introduction is strongly justified?

2 Methodology: experimental apparatus, numerical methods, model assumptions, etc.

This section explains how the study was done. Since the study was done in the past, the past tense of verbs (e.g., was/were) should be used. This section must provide sufficient detail such that another researcher working in the same field could reproduce all of the results that will be reported later in the paper. A useful exercise for the authors in preparing this section is to imagine that the entire study will be performed over again, but with different personnel: What instructions would you give these new personnel so that they could repeat the study, unencumbered by unnecessary details and giving only the ingredients essential for a successful reproduction of your study? The most important factors should be conveyed first, with details of lesser importance coming later.

[3] A common critique from reviewers is that the paper under review appears to recycle an earlier study from the same authors or the authors appear to be spreading one study over several papers in order to multiply publications. The authors are encouraged to address this potential criticism by clarifying the relation to their earlier papers in the Introduction.

2.1 Numerical studies

- [ ] Is sufficient detail given such that a computational researcher in the field could—in principle—simulate and reproduce the results reported in the paper?

- [ ] Has the numerical method been validated against standard test cases relevant to the problem being studied? If validation has been performed in previous studies (by the authors or others), these studies can be briefly summarized and cited. If the numerical method has not been previously validated, then a validation exercise is required. If the numerical validation study is too long or breaks the logical flow of the paper, the authors should consider reporting this study in an appendix or in electronic supplementary material.

- [ ] Are the details of the numerical boundary and initial conditions provided?

- [ ] Is the influence of numerical resolution on the results reported? For example, if a finite difference method is used, how do the results change if the spatial and temporal step size is decreased? Are the results in dependent of the numerical step size? Are the results fully converged?

- [ ] The authors are encouraged to review the AIAA Editorial Policy Statement on Numerical and Experimental Accuracy.[7] While *Shock Waves* does not explicitly follow this policy, the AIAA Policy Statement is exemplary in requirements for statement of methods, demonstration of convergence, etc., and authors are encouraged to consult it.

2.2 Experimental studies

- [ ] Is sufficient detail given such that another experimental researcher in the field can reproduce all of the results reported in the paper?

- [ ] Is the experimental apparatus described in sufficient detail such that any feature of the apparatus that could have an influence on the results is made available to the reader? If the description of the complete apparatus becomes excessively long, consider using electronic supplementary material to provide the complete apparatus description.

- [ ] Are the suppliers, model number, etc., of crucial equipment (e.g., pressure transducers, high-speed cameras, etc.) used in the study provided? If the use of a particular instrument might have an influence on the analysis or interpretation of results (e.g., the frequency response of an piezoelectric sensor in a study of aeroacoustics), then the complete details should be given.

- [ ] Unless the data acquisition system contained novel elements or was a major development effort in the study, it is **not** necessary to present the details of the hardware (e.g., the oscilloscope make and model, data acquisition card, etc. do not need to be given). For example, if the measurement encountered complications due to the bandwidth limitations of the oscilloscope, then the details of the oscilloscope should be provided.

- [ ] The authors are encouraged to review the AIAA Editorial Policy Statement on Numerical and Experimental Accuracy.[7] While *Shock Waves* does not explicitly follow this policy, the AIAA Policy Statement is exemplary in requirements for statement of experimental error, and authors are encouraged to consult it.

3 Results

The Results section should present the results—or a sample of results—initially in the form of source data (so-called *raw form*), without interpretation. The reason for this is as follows: The results might be useful to future researchers, even if the authors' analysis or interpretation is wrong. Thus, the results first should be presented on their own, as much as possible without subjective judgment of what the results mean; analysis and interpretation should come in a separate section or subsection.[4]

[4]The motto of the Royal Society, the oldest national science institution in the world, is *Nullius in verba*, which means, "Take no one's word." Instead of *telling* the readers their findings, authors are encouraged to *present their factual evidence* in a clear fashion so that the reader arrives at the correct conclusion on their own, without having to accept the authors' conclusion on authority.

The use of subsections and sub-subsections is highly encouraged to assist in organizing the presentation of results. For example, a sample result might be presented in detail first as a subsection, and then subsequent results in which parameters are varied systematically can be reported in separate subsections.

- [ ] Results should be reported in as factual and objective way as possible, initially without interpretation or discussion.
- [ ] If results are shown from previously published studies (earlier publications of the authors or others), these should be introduced in the literature review of the Introduction. New citations should not be introduced in the Results section.
- [ ] In presenting work performed or results obtained, the past tense (e.g., was/were) should be used.
- [ ] Subsections and sub-subsections should be used to organize presentation of results. Note that if there is a subsection 3.1, there must be a subsection 3.2. Similarly, if there is a sub-subsection 3.1.1, there must be a sub-subsection 3.1.2.

4 Analysis and Discussion

- [ ] Interpretation of the results should be presented in a separate section (or subsection of the Results), distinct from the reporting of source data.
- [ ] Conjecture and suggestion of hypotheses that are not verified in the present study are acceptable in a Discussion section, but speculation should be clearly identified as such and not presented as results or conclusions.
- [ ] Avoid presenting future plans or next steps. Deficiencies of the present study may be discussed and possible solutions described, but a scientific paper is not a future research plan or proposal.

5 Conclusion

- [ ] Is the problem that was defined in the Introduction briefly restated, along with the solution or treatment developed in the present study?
- [ ] Are the major findings of the study briefly summarized?
- [ ] The Conclusion should typically be less than half a page, when formatted in journal publication format.

Acknowledgments

- [ ] Remove academic and honorific titles (Dr., Prof., Ms., Mr., etc.). In acknowledging individuals, use either first (given) and last (family) name or first initial and last name only.
- [ ] Authors should refer to themselves by initials only ("RPF would like to thank...").
- [ ] Dedications are not permitted.
- [ ] If an author is deceased, a statement may be added to the author information: "J. Smith—Deceased", but not in the Acknowledgments.
- [ ] Complete name of funding organization should be used, not abbreviations.

Appendices

Appendices should be used for material that is of secondary importance to the main flow of the paper. Topics that are covered in the Appendices may be too long or extraneous and would risk distracting or boring the reader in the main paper. Topics that would be appropriate for Appendices include:

- Lengthy derivations of equations
- Studies of numerical convergence, grid resolution studies, etc.
- Validation calculations or test cases
- Details of experimental apparatus
- Sample preparation techniques
- Results of repeated experiments or experiments with systematic variation of parameters.
- Alternative treatments of problem considered in the main text.
- Details of algorithms used to process or analyze results.

If the Appendices consume more than a few pages, the authors should consider submitting the material as Electronic Supplementary Material instead (see below).

☐ Appendices should be numbered, starting with "Appendix 1" followed by a title (similar to a section heading). If there is only one appendix, it should just be "Appendix" (no number) with a title optional.

☐ Numbering of equations and figures should continue in the Appendices sequentially. If the last figure of the paper was Fig. 7 and the last equation was Eq. (12), the first figure and equation of the Appendix should be Fig. 8 and Eq. (13), respectively.

☐ The Appendices must be introduced in the main text of the paper, so that their connection to the main body of the manuscript is made clear. The following text should be used:

- "...may be found in the Appendix..."
- "...may be found in Appendix 3..."

☐ If Appendices consume more than three or four pages, consider submitting the material as Electronic Supplementary Material.

References

Proper attribution of prior ideas and results is the process by which researchers can built on each other's works and is a foundation of the scientific enterprise. Authors should only cite papers they have thoroughly studied and used in their research. Papers should not be cited superficially in order to increase the citation count of a paper (either those of the authors or other researchers).

The reference information must be accurate so that readers may obtain the references cited. Citation counts are also critical to proposal evaluations, hiring, tenure, and promotions, and the reference information must be accurate to ensure citations are correctly attributed to the researcher. Thus, all reference information must be verified to be accurate by the authors prior to manuscript submission. Authors are strongly encouraged to export reference information directly from the publisher's web site, rather than typing references by hand. Even if exporting reference information from the publication website, authors should verify the information is accurate, especially for older (pre-2000) papers for which optical character recognition was often used to generate the citation information.

The format for references is as follows:

- Journal article:

  Hamburger, C.: Quasimonotonicity, regularity and duality for nonlinear systems of partial differential equations. Ann. Mat. Pura Appl. **169**, 321–354 (1995). https://doi.org/10.1007/BF01759359

- Conference papers:
  AIAA paper:

    Barth, T., Jespersen, D.: The design and application of upwind schemes on unstructured meshes. 27th Aerospace Sciences Meeting, Reno, NV, AIAA Paper 1989-366 (1989). https://doi.org/10.2514/6.1989-366

  Combustion Symposium paper (after 1999):

    Wolanski, P.: Detonative propulsion. Proceedings of the Combustion Institute **34**(1), 125–158 (2013). https://doi.org/10.1016/j.proci.2012.10.005

  Combustion Symposium paper (prior to 1999):

    Meyer, J.W., Oppenheim, A.K.: On the shock-induced ignition of explosive gases. Symposium (International) on Combustion **13**(1), 1153–1164 (1971). https://doi.org/10.1016/S0082-0784(71)80112-1

  ICDERS paper:

    Gaathaug, A., Vaagsaether, K., Bjerketvedt, D.: Detonation failure in stratified layers—the influence of detonation regularity. 26th International Colloquium on the Dynamics of Explosions and Reactive Systems, Boston, MA, Paper 908 (2017)

  Detonation Symposium paper:

    Finger, M., Hornig, H.C., Lee, E.L., Kury, J.W.: Metal acceleration by composite explosives. 5th International Symposium on Detonation, pp. 137–152. Office of Naval Research (1970)

- Book:

    Geddes, K.O., Czapor, S.R., Labahn, G.: Algorithms for Computer Algebra. Kluwer, Boston (1992). https://doi.org/10.1007/b102438

- Book chapter:

    Broy, M.: Software engineering—from auxiliary to key technologies. In: Broy, M., Denert, E. (eds.) Software Pioneers, pp. 10–13. Springer, Heidelberg (2002). https://doi.org/10.1007/978-3-642-59412-0_1

- Online document:

    Cartwright, J.: Big stars have weather too. IOP Publishing PhysicsWeb. http://physicsweb.org/articles/news/11/6/16/1 (2007). Accessed 26 June 2007

☐ References should be numbered in the order they appear in the main text. References should **not** be numbered or ordered alphabetically.

☐ List all authors of a source. Do **not** use "et al." in the list of references.

☐ Do not cite internal, classified, or not-for-public-release documents. All material cited should be accessible via a university or research library.

☐ Avoid using personal communications as sources unless absolutely necessary.

☐ Some papers are available as both conference papers and journal papers. For example:

- Conference paper:

    Pilon, A.R., McLaughlin, D.K., Morris, P.J., Powers, R.W.: Design and Analysis of a Supersonic Jet Noise Reduction Concept. 52nd Aerospace Sciences Meeting, AIAA SciTech Forum, AIAA Paper 2014-0525 (2014). https://doi.org/10.25/6.2014-052514

- Journal article:

Pilon, A.R., Powers, R.W., McLaughlin, D.K., Morris, P.J.: Design and Analysis of a Supersonic Jet Noise Reduction Concept, Journal of Aircraft, **54**(5), 1705-1717 (2017). https://doi.org/10.2514/1.C033977

In general, the final, archival journal version of the paper should be referenced, rather than the conference paper version. The journal paper version is more likely to be the corrected version, and journal papers are usually more accessible than conference papers. Exceptions might be made if there are substantial differences between the versions (i.e., an error may have been introduced in typesetting for the journal that is not present in the author-prepared conference paper) or, in reviewing development of a concept, it may be important to establish the primacy of the earlier conference paper. In these cases, authors should consider referencing **both** versions.

☐ Provide DOI numbers for all references for which DOI numbers exist. The DOI (Digital Object Identifier) is a permanent link to the electronic version of a reference that will always work, even if the publisher's website (and thus the paper's web address) changes. Making the DOI number available greatly facilitates verifying the reference information is correct and also makes it very easy for a reader to locate the original reference.

☐ Note that DOI numbers exist for all AIAA publications, including all AIAA conference papers, papers appearing in the AIAA Progress and Astronautics and Aeronautics series, and many AIAA-published books, via https://arc.aiaa.org/

☐ DOI numbers exist for many books, particularly for those published after 2000. Please check the publisher's website to see if a DOI number exists for the book being referenced:

- https://link.springer.com/
- https://www.sciencedirect.com/ (Elsevier, now including Academic Press and Pergamon Press books)
- https://onlinelibrary.wiley.com/
- https://www.cambridge.org/
- https://www.taylorfrancis.com/ (includes CRC Press books)

Be careful to reference the book and **not** a review of the book. When searching for a book via Google Scholar, Google Scholar often finds reviews of the book in journals rather than the book itself. A reference to a review of a book is **not** an acceptable substitute to referencing a book.

☐ Providing ISBN numbers for books is **not** required.

☐ Are all references listed at the end of the paper cited in the text?

☐ Do all citations in the text appear in the reference list?

☐ Have the authors verified all reference information to be accurate?

☐ Have the authors verified that DOI links work and connect to the correct paper?

Part III. Language

Authors often submit a paper knowing that the language is less than perfect, hoping that the paper will be accepted on its scientific merits, and then the authors will address the language and formatting issues later. The Editorial Board views this approach as a mistake. In our experience, papers that are poorly written face a much more difficult time in the peer review process, due to reviewers being confused or annoyed by poor writing. A poorly written paper may encounter extended delays or outright rejection due to language issues, even if the scientific content in the paper is considered acceptable. **Language issues are—by far—the issue that results in the most significant delays in the peer review, editorial, and production process.**

Authors should be aware that technical translation and proofreading services do not, in general, have technical expertise in the specific field of the paper and will not understand correct usage of technical terms. Thus, even if a translation or proofreading service is used, authors are still required to have a highly proficient or native English speaker with expertise in the field of study review their manuscript for correct technical language.

☐ If authors are non-native English speakers, has the manuscript been edited for language by an experienced or native English speaker with technical expertise in the field?

☐ Either U.S. or U.K. English (e.g., behavior vs. behaviour, centerline vs. centreline) is acceptable, however, a consistent standard should be adopted throughout the manuscript (including figure labels). A software-based spelling check usually has an option for U.S. or U.K. spelling.

☐ Use of the correct article ("a/an" and "the") is important. We appreciate that selecting the correct article is difficult for writers whose native language does not use articles, but the use of one or the other article can change the meaning of a sentence:

(a) "A few results were discarded due to noise."
(b) "Few results were discarded due to noise."

Sentence (a) means that the authors are acknowledging they had issues with noise, and this meant they had to discard some results; noise **was** an issue. Sentence (b) means that noise was not much of an issue, and thus not that many results were excluded; noise **was not** a significant issue. Thus, the meanings are quite different. Another example:

(a) "Transition to turbulence was a suspected factor."
(b) "Transition to turbulence was the suspected factor."

In sentence (a), the authors believe that turbulence was one of many possible factors. In sentence (b), the authors believe that turbulence was the only possible factor. If in doubt, authors are encouraged to discuss with a native English speaker which article they should use.

☐ When a noun is used as a modifier before another noun, the first noun should be singular, even if more than one item is being referred to. E.g.:

- "Detonation cell cycle" (not "detonation cells cycle") Note: "the cycle of the detonation cells" may also be used, making clear that there is more than one cell.
- "Gas bubble diameters" (not "gas bubbles diameters") Note: "the diameter of the gas bubbles" may also be used, making clear that there is more than one bubble.

☐ Search the entire document for often-repeated words, e.g., "the the", "a a", etc.

☐ When joining two parts of a sentence, "and", "but", "or", etc. are followed by a comma **only** when what follows is a complete sentence. "The diaphragm was pulled flat and mounted between the flanges" (note no comma after "and"). "The diaphragm fragments passed into the test section, and the fragments were visible in the high-speed video" (note comma after "and").

☐ Check the manuscript for these common mistakes in word usage:

- **Phenomena** is plural; use "phenomenon" for singular
- **Data** is plural; when proofreading, replace "data" with "numbers" and verify sentence is still grammatically correct. "Datum" can be used for singular.
- **affect** is a verb: "The presence of the diaphragm did not affect the results."[5]
  effect is a noun, and always preceded by an article ("an" or "the"). "The purpose of this study is to measure the effect of the boundary layer on transition to Mach reflection."[6]
- **choking** or **choked** (not chocking or chocked; note many automated spelling checkers do not recognize "choked" and may substitute another word such as "chocked")
- **et al.** (abbreviation for "et alii" meaning "and others", **not** et. al or et. al.)
- **dependent** (not dependant, which is a person)
- **gas** (not gaz)
- **monatomic** gas, e.g., He, Ar, etc. (not monoatomic or monotonic gas)
- **monotonic** function (not monatomic function)
- **precede** means "come before"
- **proceed** means "to start or continue ahead"
- **shock** (not chock or choc)
- **schlieren** (not schleiren, schlerien, etc., and use lower case "s" for first letter)
- **weighed** (not weighted, unless used with preposition "down")

☐ Check manuscript for these commonly misspelled names:

- **Bridgman** (note no "e" in Percy Bridgman's last name)
- **Chapman–Jouguet** (not Chapmann or Jouget)
- **Colella** (not Collela)
- **Fickett** and Davis (not Ficket)
- **Rayleigh** (not Raleigh or Rayliegh)
- **Richtmyer** (not Richtmeyer)
- **Riemann** (not Reimann)
- **Wendroff** (not Wendrof)

☐ Verify that all parentheses are matched (i.e., no un-matched left/open or right/closed parentheses)

☐ Have the authors performed a software-based spelling and grammar check?

Style

Style refers to issues that—while not grammatically incorrect and not likely to be detected by a software-based spelling and grammar checker—either are or are not appropriate for scientific manuscripts.

☐ A paragraph should contain at least three sentences—preferably four or more—that develop a single concept. Single sentence paragraphs should not be used.

☐ Do not start a new paragraph after an equation. The text following an equation is usually an extension of the text preceding the equation and should continue the same paragraph. Thus, do not indent the line of text following a paragraph.

☐ Verb tense should either be present tense or past tense as follows:

  ☐ Past tense (e.g., was/were) should be used when discussing prior literature. E.g.:

[5] Affect can be a noun meaning "a display of emotion", but this usage is not usually encountered in scientific writing.
[6] Effect can be a verb meaning "to bring into existence", but this usage is not usually encountered in scientific writing.

- "Grad [18] **provided** (**not** provides) a more rigorous basis to derive the N–S–F equations from the Boltzmann equation via moment equations."

☐ Past tense should be used when discussing specific work performed by the authors, including experimental procedures and numerical simulations. E.g.:

- "The test section **was evacuated** to a pressure of 10 Pa prior to filling the test mixture."
- "A mirror boundary condition **was applied** on the symmetry axis."
- "The results of the simulation **were post-processed** using a fast Fourier transform."

☐ Past tense should be used when discussing specific experimental or computational results. E.g.:

- "The results of the simulation **showed** that the boundary layer transitioned between $x = 1.8$ and 2.2 m"
- "The shock **emerged** from the open end at a Mach number of 2.2"

☐ Present tense (is/are) should be used when discussing general or universal behavior or phenomena, including the results of the present study. E.g.:

- "Transition to turbulence usually **occurs** at Reynolds numbers exceeding 10^6"
- "Low-order methods **cause** excessive smearing of the shock."

☐ The future tense should be avoided.

☐ A consistent verb tense (present or past) is usually adopted for each paragraph.

☐ Use of **which** and **that**: Use **which** to start a clause that is **not** essential to the meaning of the sentence. Use of **which** should always be preceded by a comma, and another comma (or period) should be used at the end of the clause. Use **that** to convey information that is required for the intended meaning of the sentence. Consider these two examples:

(a) "The test section, which was fabricated from 304 stainless steel, was located between the nozzle section and the dump tank."

(b) "The reentry vehicle model that had the greatest radius of curvature resulted in the least stagnation point heating."

In sentence (a), the fact that the test section was stainless steel is not essential to the meaning of the rest of the sentence, so **which** was used and the clause was set apart by commas. In sentence (b), the information that the model with the greatest radius of curvature is being discussed is essential to convey the meaning of the sentence, so **that** is used without commas. A simple test authors may use is: Read the sentence without the clause. If the sentence still makes sense, use **which** and commas around the clause. If the sentence does not make sense, use **that** without commas. Additional examples are provided here:

- "The results were recorded via high speed video, which was positioned perpendicular to the viewing window." (Note phrase after "which" provides extra information, but is not required for the sentence to make sense.)
- "Both shock waves reflected from the wall. The shock wave that emerged from the tube exit reached the wall-mounted transducer first." (Note lack of comma since the information "that emerged from the tube exit" is required for the sentence to make sense.)

☐ Do not use quotes when referring to labels on figures, states, etc. For example: "In Fig. 4, this state is denoted S." Note there are no quotes around S and it is not in italic.

☐ Do not start sentences with numbers or symbols. E.g., "η denotes the perturbation growth rate" is better as: "The variable η denotes the perturbation growth rate".

☐ Do not start sentences with "It", "That", "This", etc., and do not use pronouns (e.g., it, this, that) as the subject of a sentence. The reader may not know what these pronouns refer to, so writing the actual word that "it" refers to is preferred. Repeating the same words several times in a paragraph is preferred over using "it", etc., at the start of sentences.

☐ Avoid excessive use of "however", "contrarily", "whereas", "nevertheless", "on the other hand", etc. These words denote what follows is in contradiction to what preceded them, and often makes for confusing logic that is difficult for the reader to follow. For example:

- "However, characterizing impulsive and extremely short duration test flows is a difficult and complex problem in itself, and this challenge has not yet been fully addressed. Nevertheless, the method suggested in this study may have the potential to realize such measurement, however, it his yet to be demonstrated at realistic flow conditions. On the other hand, use of piezofilm sensors may enable these measurements to be made in a straightforward manner, but at the expense of more complicated test models. Yet, this methodology should be further explored."

Such writing is nearly incomprehensible for the reader to follow. Stating findings in as factual a way as possible is preferred over having each sentence be a counterpoint to the sentence that proceeds it.

☐ Spell out numbers less than 10, unless accompanied by a unit. E.g., "A total of eight experiments were conducted." "The result shown represents the average of 14 repeated measurements." "The pressure was decreased from 12 kPa to 8 kPa."

☐ Use the serial comma (also known as the Oxford comma) when listing three or more items in series, i.e., the comma following B here: "A, B, and C." E.g.: "conservation of mass, momentum, and energy." Authors are recommended to search every use of "and" in the manuscript to ensure that the serial comma is used consistently.

☐ Do not use contractions (e.g., can't, won't, etc.). Write out entire words as "cannot", "will not", etc.

☐ Do not use ampersand &. Write out "and" instead: "Moin and Kim", not "Moin & Kim"

☐ Always precede and follow i.e. and e.g. with a comma: "...shock capturing, i.e., the shock is represented over several computational cells...", "...several factors, e.g., diaphragm rupture, wall roughness, etc..."

☐ Avoid use of possessive apostrophe (e.g., the shock tube's diameter, the authors' earlier work, etc.). Use prepositional phrases instead: "the diameter of the shock tube", "the earlier work of the authors."

☐ Precede "respectively" with a comma: "in the x-, y-, and z-directions, respectively."

☐ Use a hyphen for compound adjectives and qualifiers, e.g., shock-compressed gas, a three-stage, third-order Runge–Kutta scheme, finite-rate reaction chemistry, detonation-driven shock tunnel, etc. Note that the lack or use of a hyphen can change the meaning of terms:

(a) High temperature effects
(b) High-temperature effects

Here, (a) refers to a significant (high) influence of temperature, while (b) refers to effects that only occur at high temperature.

☐ Write "flowfield" as one word (**not** flow field).

☐ Write "shock wave" as two words (**not** shockwave).

☐ Do **not** hyphenate "shock wave" or "shock tube" unless used as a modifier before another noun. E.g., "the shock-tube diameter was 50 mm" (note use of hyphen), "the diameter of the shock tube was 50 mm" (note no hyphen).

☐ Only put a hyphen between a number and a unit when used as an adjective before another noun: "the inner diameter was 10 cm", "a 10-cm-inner-diameter tube was used."

☐ Use the en-dash (in TEX: `--`) for ranges of numerical values: 45–60 kPa. Do not use the ÷ sign for numerical ranges.

☐ When terminology involves two separate concepts, these should be joined with an en-dash (in TEX: --). E.g., shock–bubble interaction, Navier–Stokes equations.

☐ Do not use a slash (/) to join concepts or terms; an en-dash should be used instead: "a methane–oxygen mixture" rather than: "methane/oxygen mixture"

☐ A slash should only be used between contrasting terms: "The laminar/turbulent nature of the flow influences separation", "the shock then encountered the open/closed ports".

☐ Avoid using a series of several adjectives and nouns in a row: "plug core jet shock fluctuations" is almost impossible to understand. Rather, break such terms into phrases, such as: "fluctuations of the shock in the plug core jet", which are more comprehensible. Similarly:

- "chemical species concentrations" is better written as: "concentration of chemical species"
- "the flow Mach number evolution" is better written as: "the evolution of flow Mach number"
- "streamwise velocity fluctuations amplification factors" is better written as: "amplification factors for fluctuations in streamwise velocity"
- "side-wall opening ratios" is better written as: "opening ratios of the side walls"
- "array holes injection method" is better written as: "the method of injecting via an array of holes."
- "the incompressible flow regime numerical simulation" is better written as: "numerical simulation of the incompressible flow regime"

☐ Do not use subjective terms such as "obviously", "clearly", "easily." The concept being presented may not be obvious, clear, or easy to the reader.

☐ Avoid slang and informal English:

- "a lot of" or "lots" instead use: "a considerable amount", "many", or "numerous"
- "fix" instead use: "maintain constant"
- "stick with" instead use: "retain"
- "though" instead use: "although"
- "till" instead use: "until"
- "at last" instead use: "finally"
- "besides" instead use: "in addition to"
- "risky" instead use: "possibility of failure"
- "reckoned" instead use: "assumed" or "reasoned"
- "tackled" instead use: "treated"
- "tweaking" instead use: "adjusting"
- "to keep it simple" instead use: "to maintain simplicity"

☐ Avoid idioms such as, "Sharply resolving a contact surface is *a hard nut to crack*." For less experienced English speakers, such idiomatic expressions may be unfamiliar.

☐ Similarly, avoid using informal or colloquial expressions such as "the experimental points **sit** on the theory curve," which is better written as "the data points are located upon (or coincident with) the theory curve.'

☐ In comparing quantitative values, authors are encouraged to use more mathematically precise words, such as "greater" and "lesser", that correspond to the mathematical symbols $>$ and $<$, rather than "higher", "bigger", "larger", "smaller", etc., that are meant to describe size or placement. Only if use of a term is widely accepted, e.g., *High-Temperature Gasdynamics*, should "high" be used to describe a numerical value.

☐ Similarly, "increasing" and "decreasing" are preferred over "jump", "drop", "fall", "shrink", etc.

☐ "Quotation marks" should only be used when directly quoting text from another source.

☐ Use "double quotation" marks rather than U.K.-style 'single quotation' marks. In TEX, this is done by repeating single quotes: ``double quotes that curl''

☐ Avoid use of "quotation marks" around terms. In English, these are usually referred to as "scare quotes" or "ironic quotes" and do not belong in a scientific paper. For example, avoid using quotes around terms like these:

- "The mixture of n-heptane and oxygen exhibited "cool" flames when heated."
- "The "weaker" Mach 5 shock then impacted the obstacle."

☐ Rather than using "quotation marks", authors may emphasize the introduction of a new term by putting the word in italic. E.g., "...we refer to this technique as *shock trapping*." Emphasizing a term in this way should be done on first use only and is not required for familiar, accepted terms.

Abbreviations and acronyms

☐ Abbreviations should only be introduced if an overly long expression is used repeatedly throughout the paper. If the term is **only used ten times or less in the paper**, the authors should consider **not** using an abbreviation or acronym. Keep in mind the reader may not remember what the abbreviation stands for and would need to continuously refer back to where the abbreviation is introduced, which may contribute to reader frustration and annoyance.

☐ Abbreviations must be defined when first introduced, and then consistently used thereafter.

☐ Only in the case of widely recognized abbreviations (e.g., FFT, RMS, CFD, etc.) could the definition of an abbreviation be left out.

☐ Articles should be used before abbreviations as if the abbreviation was written out in words. For example:

- "We consider the addition of a high pressure turbine (HPT) to the design...We also considered the first-stage stator without the HPT included." Note "the" before HPT, which would be required if "high pressure turbine" were written out in words for "HPT".

☐ Have the authors performed a software-based search of their entire document for all of the issues listed above?

Part IV. Text and Figure Formatting

Text

Variables

The *Shock Waves* journal follows a style wherein variables, and only variables, should be in italic. Variables should be a single letter, either Latin or Greek. Subscripts and superscripts on variables that are letters, abbreviations, or words, should not be in italic, but rather roman (upright) font. Only if a subscript is itself a variable (such as subscript p on c_p or the z-direction subscript on velocity component v_z) or an index (such as i, j, k on u_i, etc.) should italic be used on a subscript. A superscript should only be in italic if it is a variable appearing in an exponent.

When deciding if a symbol should be in italic or not, the authors should consider the following question: **Can the symbol be assigned a numerical value?** If **yes**, then the symbol should be in italic. If **not**, then roman (upright) font should be used.

For example, the heat capacity at constant volume for the vibrational mode should be expressed $c_{v,\mathrm{v}}$, which in TEX is: `$c_{v\mathrm{,v}}$`, where the first v subscript denotes specific volume, the variable being held constant in defining the heat capacity, i.e., $c_v = \left(\frac{\partial u}{\partial T}\right)_v$, and is therefore in italic. The second v is an abbreviation for vibration and is not in italic.

In addition to being the standard of Springer journals, the convention defined here generally follows that of the International Union of Pure and Applied Chemistry [8], the National Institute of Standards and Technology [9], and International Organization for Standardization (ISO) [10]. Adopting a common standard in formatting of symbols can facilitate the ease of readers in understanding and applying the results of a paper. In implementing a numerical algorithm described in an article, for example, it is very helpful for readers to know which symbols are numerical variables and which are labels.

- ☐ All variables are in italic, including in equations, main text, tables, figure captions, and figure labels.
- ☐ All subscripts are in upright (roman) font (in TEX: `\mathrm{}`), unless the subscript is itself a variable or an index. E.g., for M_s, p_ref, T_cr, u_max, etc., the subscript is non-italic, since "s" is an abbreviation for "shock," etc. For u_i, σ_{ij}, c_p, etc., the subscript is itself a variable (p is pressure) or an index (i, j, k, etc.) and thus is italic.
- ☐ All superscripts are in upright (roman) font, unless the superscript is itself a variable appearing in an exponent.
- ☐ Parameters denoted by more than one letter (e.g., CFL, RMS, etc.) should not be in italic.
- ☐ Nondimensional parameters denoted by two letters should be in roman (upright) font: Re (Reynolds number), Pr (Prandtl number), Kn (Knudsen number), etc. Do **not** use italic for nondimensional parameters.
- ☐ Reynolds number as a function of x-position should be written as Re_x, (in TEX: `$\mathrm{Re}_x$`), as a function of diameter Re_D, etc.
- ☐ Mach number should be denoted with M in italic. Although Mach number is a nondimensional parameter, in compressible flow it more typically plays the role of a variable and so should be in italic.
- ☐ Do not use Ma for Mach number; Ma is reserved for the nondimensional Marangoni number for surface tension.
- ☐ For papers examining multiphase flows, subscripts required for properties of gas, solid, vapor, etc., should be in roman (upright) font: h_g, h_s, h_vap. For liquid, a roman "l" may be confused with the numeral for one, so it is recommended to use a script "ℓ", as follows: h_ℓ, (in TEX: `h_$\ell$`).
- ☐ Have the authors performed a software-based search of their entire document for all of the issues listed above?

Other mathematical notation

- [ ] Vectors, matrices, and tensors should be in bold, upright font (in TEX: `\mathbf{}`). Matrices and tensors should use a capital letter.
- [ ] Avoid use of arrows over symbols to denote vectors. E.g., velocity vector should be denoted $\mathbf{v}$ rather than $\overrightarrow{v}$
- [ ] Functions (exp, sin, cos, ln, log, max, min, etc.) should be in lower case letters and roman (upright) font, **not** italic. In TEX, this can be done via `$\exp$`, `$\sin$`, etc.
- [ ] The base of natural logarithms or Euler's number (2.71828...) should be in roman (upright) font: e (**not** e)
- [ ] The square root of minus one should be in upright font: i
- [ ] The differential operators d and D should be in roman (upright) font, **not** italic. E.g., $\frac{\mathrm{d}y}{\mathrm{d}x}$, $\frac{\mathrm{D}\mathbf{V}}{\mathrm{D}t}$, $\int_{T_{\mathrm{ref}}}^{T} c_p(T)\,\mathrm{d}T$
- [ ] The transpose operator should be in roman (upright) font. E.g., $\mathbf{F} = [\rho\,u, p + \rho\,u^2, (e+p)u]^{\mathrm{T}}$
- [ ] Do not use a slash (/) to represent a fraction to avoid ambiguity. E.g., $2/(\gamma - 1)$ is better written as $\frac{2}{\gamma - 1}$. In TEX: `\frac{2}{\gamma-1}`
- [ ] Use a period (.) for the decimal point, not a comma: 3.1416 (**not** 3,1416).
- [ ] Use a zero before decimal point: 0.001% (**not** .001%)
- [ ] For numbers greater than ten thousand, use a comma or space to separate every three orders of magnitude: "3 400 000 cells were used" or "3,400,000 cells were used". For numbers less than ten thousand, do not use a comma or space: "The critical Reynolds number was 2300."
- [ ] Use scientific notation as follows: 6.022×10^{23}, not 6.022E23. The 6.022E23 form may be used in large tables (e.g., rate parameters in detailed chemical kinetic models) to save space.
- [ ] Use the correct $\times$ symbol; do **not** use x or *. In TEX: `$\times$`.
- [ ] Put a space around mathematical operations such as +, −, ×, =, etc. The one exception is / for division, which should not have spaces around it, e.g., $1/\left(M^2 - 1\right)$.
- [ ] Use $\approx$ (in TEX: `$\approx$`) for approximately equal. E.g., "The post-reflected-shock pressure was measured to be $p_{\mathrm{r}} \approx 77$ kPa."
- [ ] Use $\sim$ (in TEX: `$\sim$`) for "same order of magnitude" and "varies as." E.g., "Hypervelocity impact results in pressures of the order of $P \sim 100$ GPa", "Temperature varies with shock Mach number as $T \sim M_{\mathrm{s}}^2$." The symbol $\propto$ (in TEX: `$\propto$`) can also be used for a more mathematically precise "proportional to" or "varies as".
- [ ] Verify all parentheses and brackets are matching (i.e., equal number of opening and closing parentheses) and properly nested in text and equations. E.g., $\{\,[\,(\,\ldots\,)\,]\,\}$
- [ ] Have the authors performed a software-based search of their entire document for all of the issues listed above?

Units

- [ ] Use units recognized by the International Union of Pure and Applied Physics (IUPAP) or defined by ISO.
- [ ] Unit abbreviations should be used even when writing text and in tables, figure captions, and figure labels. E.g., "The opening time of the diaphragm was measured to be approximately 100 ms", "The spark energy was 100 mJ" (Note: Do **not** write out "milliseconds" or "millijoules"). Unit abbreviations do **not** need to be defined in the paper.

- [ ] Use μm for microns (micrometers). Note that μ is not in italic (compare to μ), since it is not a variable. In TEX, use `$\upmu$m` for μm, which requires `\usepackage{upgreek}`.

- [ ] Numbers followed by units should have a non-breaking space between them so that they are not split over a line or page break. In TEX, this is done with tilde: `5~mm`. In MS Word on a PC, `contrl-shift-space` can be used to make a non-breaking space. In MS Word with Mac OS, place your cursor after the first number you want to keep together, hold the option key as you press the space bar, and then type the unit.

- [ ] Number with units that form a compound adjective before a noun should be hyphenated: "The 5-cm-inner-diameter tube", but note "The tube was 5 cm in inner diameter" is **not** hyphenated.

- [ ] Use the proper degree symbol (°), not a superscripted o or 0. Do not write out the word "degrees". In TEX, `$^{\circ}$` can be used for the degree symbol.

- [ ] When reporting angles, do not put a space between number and degree symbol: 30°

- [ ] Temperature should be reported in Celsius or Kelvin as follows: 23 °C or 273 K. (Note no degree symbol for K.) In TEX: `23~$^{\circ}$C`

Chemical Formula

- [ ] Do **not** put chemical formulas in italic. E.g., C_2H_4. in TEX: `C$_2$H_$4$`

- [ ] Do **not** put prefixes such as n- and iso- in italic, e.g., n-butane, iso-octane. "n" here is an abbreviation for "normal", not a variable.

Figures

Figures are the main drivers to convey results. Preparation of quality figures is a significant undertaking and may consume as much time as obtaining the results themselves. Carefully prepared, clear figures can greatly impress readers and powerfully convey the significance of the results. Poorly prepared figures can communicate to the readers a careless approach to the research on the part of the authors.

Figures may be imported into the text and appear in the main body of the paper as they are discussed; many readers appreciate having the figure visible at the appropriate location in the text. Authors may choose to only submit figures separately, in which case the figures would appear at the end of the PDF file that is distributed to reviewers. If the authors embed their figures in the text, they are encouraged to also submit each figure as a separate file so that the quality of the original images may be examined. Generation of the PDF version of the paper may result in figures embedded in the main text being corrupted or appearing in lower resolution.

- [ ] Do the figures—without reading the main text—tell the complete story? I.e., a reader should be able to understand the problem, the authors' approach, and the main results by examining the figures alone.

- [ ] Is one of the first figures in the paper a visual presentation of the problem (e.g., schematic, rendering, photograph, etc.).

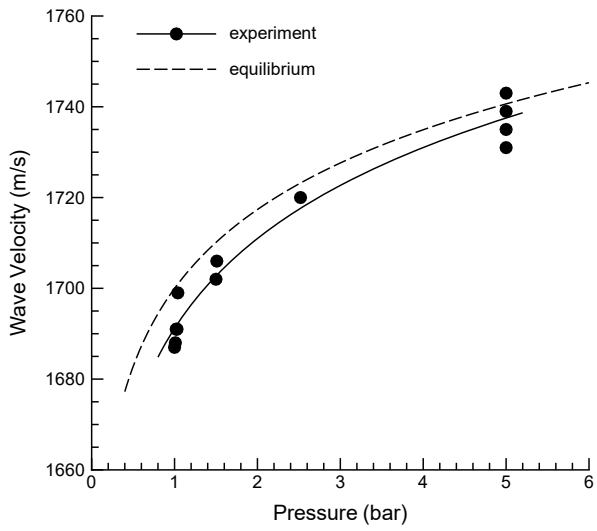
- [ ] The direction of flow (usually, left-to-right) should be consistent for all figures. For example, experimental images may be mirror-imaged to make the flow direction consistent with the figure presenting the experimental apparatus. Similarly, visualization of computational results should be consistent in the direction of flow with the schematic presenting the problem being studied.

- [ ] Figures should **not** have a box that encloses the entire figure (graphs with all axes forming a box is acceptable).

- [ ] Graphs should **not** have a title above the graph. Text describing the graph should be given in the caption.

- [ ] Avoid excessive use of color. While *Shock Waves* prints papers in full color, colors often appear different when printed or viewed on different devices. Light colors often disappear or are very difficult to distinguish. The use of fewer (rather than more) colors that are darker (rather than lighter) are preferred. Plotting curves with

(a) Acceptable plot



(b) Unacceptable plot

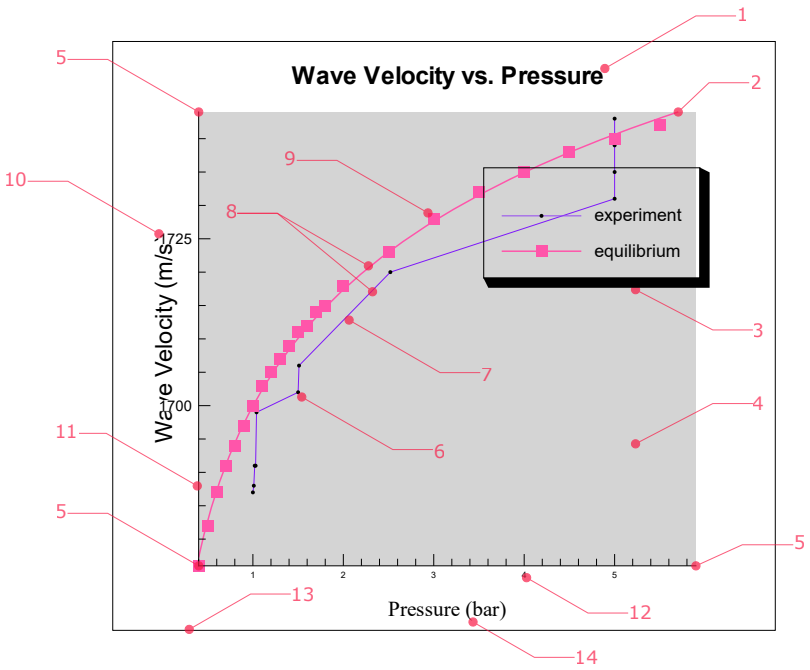


Figure 1: Examples of **a** acceptable and **b** unacceptable plots. In plot (b), the following issues are identified: (1) Plots should not have titles. (2) Data extends to the edge of plot; a wider range should be used on axes. (3) Legend interferes with data being plotted. Also, box around legend is unnecessary. (4) Grey background should be removed. (5) All axes should start and end on a significant tick mark with a number label. (6) Symbols used for data are too small. (7) Connect-the-dots line has no physical meaning and should be removed or replaced with a curve fit through data. (8) Unnecessary use of colors; colors are too pale. (9) Symbols should not be used for calculations that could be run with sufficiently close spacing that a smooth curve could be used instead. (10) Axes label interferes with numbers. (11) Axis line is too thin or missing. (12) Font too small. (13) Do not put box around entire plot. (14) Inconsistent font: Label is in Times New Roman (serif) font while rest of plot uses sans serif font.

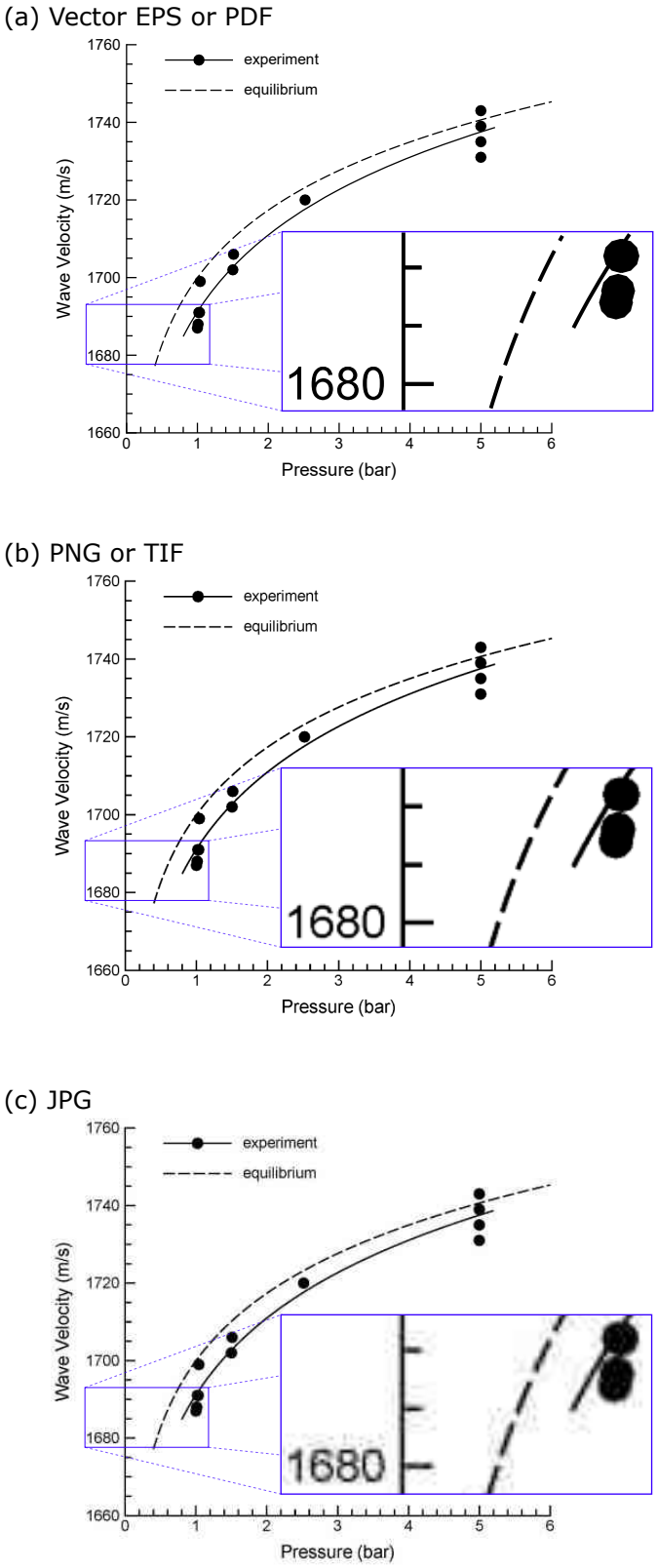


Figure 2: Comparison of **a** vector EPS or PDF image, **b** PNG image, and **c** JPG image. Note that the JPG image exhibits artifacts (speckling) due to lossy compression. For this reason, JPG should never be use for anything other than digital photographs.

each curve a different color does not usually enhance reader comprehension. Some colors may be difficult for persons who have color blindness or vision impairment to differentiate. Figures should aim for a minimalist aesthetic in the use of color, as opposed to Disney-style Technicolor.

- ☐ In making color-filled contour plots, use of rainbow color maps, in which most or all the colors in the spectrum of visible light are used, is discouraged. In scientific visualization, a general trend away from using rainbow color maps is occurring, with use of sequential or divergent color maps encouraged rather than rainbow color maps.[11] The rapidly changing colors in rainbow color maps often accentuate the wrong details in a visualization; this issue is discussed in greater detail in [12], [13], and [14].

- ☐ Print figures at the size they will appear in journal format in black and white and verify all lines and shading is visible.

- ☐ Plots generated by Microsoft Excel or other spreadsheet software are usually not of sufficient quality to be acceptable for publication. Authors are strongly encouraged to use scientific plotting software such as Tecplot, Origin, etc.

- ☐ Do not make "connect the dots" plots for data that has inherent scatter. A line or curve should only be plotted if it has some physical significance. For data that has scatter, either due to experimental error or irreproducibility in the phenomenon itself, plotting just symbols is recommended. Connecting the symbols with line segments (see Fig. 1b) implies that the lines connecting the symbols have some physical meaning, and readers may misinterpret the plot by focusing on the kinks between the line segments. If a curve is desired, using a smooth curve fit through the data is preferred (see Fig. 1a).

- ☐ Results generated from analytical theory or computations should be plotted as curves rather than symbols, provided a sufficient number of cases can be calculated to generate a smooth curve. For larger computations with significant run times, this may not be possible. For analytic computations, equilibrium and chemical kinetic calculations, etc., generation of an effectively smooth curve should be possible, in which case, a smooth curve should be plotted without symbols (e.g., see the equilibrium calculation in Fig. 1a vs. Fig. 1b)

- ☐ Drawings generated by CAD software are generally not acceptable unless nonessential information is removed.

- ☐ Screen shots of oscilloscopes or data acquisition software are not acceptable. Data should be plotted using scientific plotting software.

- ☐ Screen shots of commercial or open-source simulation software (CFD, FEA, etc.) are not usually acceptable.

- ☐ Figures should be referenced where they are first presented and discussed in order. Do not mention Fig. 2 in the text until Fig. 1 has been presented.

Figure File Format

Figures should be submitted in vector EPS or PDF format in which lines and text remain sharp when zoomed in upon. If such files are used, line information is given by endpoints and plotted on screen or paper when the PDF version of the paper is viewed or printed, using the highest resolution available. Text is also stored in the file as text and will always appear sharp (not pixelated). An additional advantage of submitting vector EPS or PDF files is that it may be possible for the Production Department to correct minor spelling errors by editing the text in the file.

- ☐ Figures should be submitted in line vector format, where lines and text remain sharp when zoomed in upon. File formats such as EPS and PDF can preserve lines and text as sharp lines and text. Authors should explore options such as "save to EPS/PDF" or "print to EPS/PDF" in their drawing, plotting, and visualization software.

- ☐ EPS and PDF files should use embedded fonts (often appears as an option when saving).

- ☐ If authors are unable to provide vector EPS or PDF files, then raster (bit-mapped) images may be used, but should be a **minimum** of 1200 dpi (500 dpcm) when printed at the size they will appear in journal format. Image files should typically be 4000 pixels or more in width. PNG (preferred) or TIF (less preferred) formats should be used.

☐ JPG format should **not** be used, except for photographs (for example, of experimental hardware). JPG should never be used for line drawings, plots, or visualization of simulations due to the generation of artifacts resulting from lossy compression (see Fig. 2c)

☐ Low-resolution scans from other papers or reproductions of figures that have been photocopied are generally unacceptable. If authors wish to reproduce data from older graphs or archival figures, they should explore using data extraction software (e.g., WebPlotDigitizer, Datathief, etc.) and re-generate plots using modern plotting software.

Electronic supplementary material

Submission of electronic supplementary material is highly encouraged. Authors are encouraged to use this option to archive their experimental results. The availability of results in an easily accessible, machine-readable format increases the likelihood that the results of a paper will be used—and cited—by other researchers. Items that would be appropriate to include as electronic supplementary material include:

- Data from a large number of systematic experiments or simulations. I.e., if a plot in the main paper shows measurements made at one Mach number, then experimental plots of similar results performed at different Mach numbers could be submitted as supplementary material.
- Long analytical derivations
- Numerical convergence studies, studies of grid resolution, etc.
- Numerical benchmark computations performed as code validation (e.g., Sod's shock tube problem)
- High-speed movies
- Animations
- Code used for processing of results, including Python and MATLAB script files, Mathamatica notebooks, etc.
- Spreadsheets of experimental results

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