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SPHERIC
NEWSLETTER

36th issue

SPH rEsearch and engineeRing International Community

SUMMARY

18th SPHERIC International Workshop in Berlin (June 17–20, 2024)

Local Organizing Committee
Dive Solutions, Berlin, DE

Dear Researchers, Academics, and Professionals,

We invite you to submit your abstracts for consideration at the 18th International SPHERIC Workshop, scheduled to take place from June 18 to June 20, 2024, in Berlin, Germany. This event serves as the only dedicated international event for the exchange of cutting-edge research and ideas in Smoothed Particle Hydrodynamics (SPH).

Submission Guidelines:
· Abstracts must be submitted by **January 19, 2024**.
· The abstract should be 1 page long and must include one illustrative figure outlining the quality of the results.
· Clearly state the objectives, methods, results, and conclusions of your research.
· Include keywords relevant to your work.
· Submissions may regard fundamental SPH research or practical/ industrial applications of SPH.

Submit your abstract through our online portal at https://www.dive-solutions.de/spheric2024. Ensure that you follow the guidelines provided on the submission page. Notification of acceptance for publication will be given on or before February 12, 2024 via email.

The workshop programme includes three keynotes from prominent experts:
Dr. Martin Ferrand (Electricité de France): *How to perform Finite Volumes Methods on traditional SPH playgrounds*
Felix Pause (Dive solutions): *Current status and future trajectory of SPH in industrial engineering simulation*
Prof. Dr. Abdulla Ghani (TU Berlin): *Physically informed machine learning using the example of reactive flows*

Key dates:

Training Day:
June 17, 2024

Workshop:
June 18–20, 2024

Abstract submission deadline:
January 19, 2024

Selected abstracts announcement
February 12, 2024

Early registration deadline
March 8, 2024

Final paper submission deadline
April 26, 2024

Presenter registration deadline
May 3, 2024

On behalf of the SPH rEsearch and engineeRing International Community (SPHERIC) the event is hosted by Dive, the particle-based simulation software-as-a-service (SaaS) provider. On June 17, the day before the workshops, a training day is offered for everyone interested in learning about fundamentals and industry applications of SPH. Attendees will have the unique opportunity to simulate an industry case within an hour using the Dive software. The SPHERIC International Workshop also includes networking opportunities like the welcome drink, the gala dinner, and the possibility to book an additional social event on June 21, the day after the workshops. The social event will take you on a tour of the history of the Berlin wall, including the Wall Museum, a boat ride on the river Spree and the eastside gallery.

On behalf of the organizing committee, we cordially invite you to share an insightful and enjoyable event with us.

Your local organizing committee
Dive Solutions

spheric2024@dive-solutions.de

A view of the venue where the event will be hosted.

7th DualSPHysics International Workshop (March 19–21, 2024)

Angelantonio Tafuni
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New Jersey Institute for Technology, NJ, USA

Key dates:

1-page abstract submission deadline:
January 15, 2024

Selected abstracts announcement
January 26, 2024

Early registration deadline
February 12, 2024

Presenter registration deadline
February 19, 2024

Regular registration deadline
March 12, 2024

Training Day:
March 19, 2024

Workshop:
March 20–21, 2024

I am pleased to announce the 7th DualSPHysics Workshop, hosted by Politecnico di Bari, Italy, on March 19–21, 2024.

The DualSPHysics Workshop brings together the ever-growing community of users and developers of the DualSPHysics open-source SPH code. The goals of this workshop are:

· to provide an opportunity for the DualSPHysics team to present the latest code advances and plans for future developments;
· to provide DualSPHysics users with a beta version of the latest code features and to discuss the performance of such features as well as to suggest new areas for development and improvement;
· to provide an opportunity for the end-users to discuss with core developers;
· to give a hands-on practical session for all interested DualSPHysics users;
· to enable DualSPHysics users to present their own work using DualSPHysics, share their experience and provide feedback on best practices.

The 7th DualSPHysics International Workshop will be held in Bari, Italy. The event is co-organized by the New Jersey Institute of Technology and Politecnico di Bari, and it is sponsored by NJIT, Politecnico di Bari, and Acquedotto Pugliese SpA. Workshop information can be found at

https://dual.sphysics.org/7thworkshop/

We look forward to your submissions and to sharing a successful and enjoyable meeting with you!

Photo: A panoramic view of Bari, where the event will be held.

2024 SPHERIC Zhuhai International Workshop (October 17–20, 2024)

Dr. Pengnan Sun
sunpn@mail.sysu.edu.cn
Sun Yat-sen University, China

Key dates:

Training Day & on-site registration:
October 17, 2024

Conference:
October 18-20, 2024

Abstract submission deadline:
July 25, 2024

Announcement of selected abstracts:
August 15, 2024

Early registration deadline:
August 30, 2024

Final paper submission deadline:
September 15, 2024

On-line registration deadline:
September 30, 2024

The 2024 SPHERIC Zhuhai International Workshop will be held in the Zhuhai campus of Sun Yat-sen University during October 17–20, 2024. The workshop will bring together researchers and practitioners from academia and industry and focuses on new concepts and applications of SPH or other particle-based numerical models.

Topics of the workshop will cover a wide variety of subjects in SPH or other particle-based numerical models, such as: theoretical and numerical challenges, numerical modelling, scientific computing, alternative formulations, industrial applications, etc. There will be an optional training day on October 17, 2024, including three lectures and one hands-on practice session using the advanced super computer cluster in Sun Yat-sen University. Four keynote speeches will be given in two days. There will be student prizes and best paper prizes awarded to authors who contribute outstanding works to workshop.

Zhuhai is known for its beautiful long coastline, waving palm trees, open spaces, low population density, and its many islands; Zhuhai's nicknames are the city of romance and the city of a hundred islands. We wish to welcome you in Zhuhai, China and share an enjoyable and fruitful SPHERIC International Workshop.

Photo: The Fisher Girl Statue is an iconic symbol of Zhuhai, a seaside city faces Hong Kong and Macao over the sea

Keynote speakers

Prof. A-Man Zhang: A-Man Zhang is a professor at Harbin Engineering University, China. He was founded by National Science Fund for Distinguished Young Scholars and was selected as the Changjiang Scholar Distinguished Professor and Science and Technology Innovation Leading Talent of the National "Ten Thousand Talents Program". His main research areas include underwater explosion, bubble dynamics and fluid-structure interactions.

Dr. Andrea Colagrossi: Andrea Colagrossi is employed as head researcher at the CNR-INM, Institute of Marine engineering of the Italian Research Council (CNR). In 2005 he obtained his PhD degree in Theoretical and Applied Mechanics at the University of Rome "La Sapienza". The main focus of his research is the theoretical and computational aspects of Mesh-Free numerical methods in naval and marine research activities.

Prof. Seiichi Koshizuka: Seiichi Koshizuka has been working as a professor of the University of Tokyo since 2004. His research subjects are particle method, computational fluid dynamics, visualization, verification and validation etc. He has been developing Moving Particle Semi-implicit (MPS) method which is one of the most popular meshless methods for incompressible viscous flow with free surface. The MPS method he developed has been commercialized by a venture company where he is one of the board members. The commercialized MPS software is currently used by various clients from industry. He received Kawai Medal from Japan Society for Computational Engineering and Science (JSCES) in 2010 and IACM Fellows Award in 2018. During 2014 to 2016, he served as the President of JSCES. He is a member of General Council of IACM.

Prof. Christian Weißenfels: Prof. Weißenfels is a professor for Mechanics at University of Augsburg, Germany. He works on Data-driven Computational Materials Science and Engineering. He is dedicated to the application of artificial intelligence algorithms to close the gaps in understanding materials and their processes and properties. Another area of his interest is to develop new simulation methods to approximate mathematical equations as accurately and efficiently as possible, even in the context of technique-demanding processes.

Training day lectures:

1. Theory and numerical aspects of weakly-compressible SPH
2. Theory and numerical aspects of incompressible SPH
3. SPH applications for different engineering problems

Training day practice session:

Hands-on practice with SPHinXsys

Awards

Student prize (The best/Outstanding/Excellent Student Paper Award): The student prizes are awarded at every SPHERIC Workshop for the best works by students, based on their presentations and final papers, as selected by the Scientific Committee.

Best paper prize: Two best paper prizes will be awarded for authors of full papers selected by the Scientific Committee in the field of (a) Fundamental SPH Research or (b) Practical SPH Applications. The authors or presenters are not limited to students.

Sun Yat-sen University (Zhuhai campus).

Zhuhai Opera House: the first on-island theater in the Chinese mainland

SPH Online V: Fifth International Online Workshop on SPH

Abbas Khayyer, Benedict D. Rogers, Matthieu De Leffe & Pierre Sabrowski
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The Fifth International Online Workshop on SPH, namely, **SPH Online V**, was held on Friday, October 6th, 2023, 8:00-11:20 UTC. The ***focus topic*** of this online SPHERIC-affiliated workshop was ***SPH & Industry***. The workshop aimed at bringing together all SPH experts and potential future developers to discuss the latest developments and future perspectives corresponding to ***industrial applications of SPH***. Registration started from early August 2023 until September 15th, 2023. We had the pleasure of welcoming more than 120 participants including distinguished invited delegates (e.g., Prof. Javier Bonet, Prof. Andrea Colagrossi, Prof. Antonio J. Gil, Prof. Hitoshi Gotoh, Prof. Seiichi Koshizuka, Prof. Damien Violeau, Prof. Shiqiang Yan). The workshop comprised a welcome message, a keynote talk, 5 invited talks, a panel discussion, and a concluding remarks speech. Detailed programme of the workshop was as follows:

Welcome Message by *Dr Abbas Khayyer* (Kyoto University, Kyoto, Japan)
8:00 – 8:05 UTC

Keynote Speech by *Dr Jean-Christophe Marongiu* (Pelton Technology Hydraulic Laboratory, ANDRITZ Hydro, Switzerland)
8:05 – 8:35 UTC
"SPH applied to flows in hydraulic turbines"

Invited Talk 1 by *Mr Marian Majda* (FIFTY2 Technology GmbH, Germany)
8:35 – 8:55 UTC
"SPH vs. CFD? From sceptics to fans"

Invited Talk 2 by *Prof. Peter Eberhard* and *Ms Elizaveta Shishova* (Institute of Engineering and Computational Mechanics, University of Stuttgart, Germany)
8:55 – 9:15 UTC
"Friction Stir Welding Simulation Using SPH"

Coffee Break (9:15 – 9:25 UTC)

Invited Talk 3 by *Mr Christof Lüthi* (Data-driven & Computational Manufacturing Group, inspire AG, Switzerland)
9:25 – 9:45 UTC
"SPH for Manufacturing Process Simulations: The Good, The Bad, and The Real World"

Invited Talk 4 by *Dr Bonaventura Tagliafierro* (The Universitat Politècnica de Catalunya, Spain and University of Wisconsin-Madison, USA)
9:45 – 10:05 UTC
"Coupling SPH with multiphysics solvers for engineering applications: WECs and FOWTs"

Invited Talk 5 by *Prof. Eung Soo Kim* (Department of Nuclear Engineering, Seoul National University, South Korea)
10:05 – 10:25 UTC
"Applications of SPH for Severe Nuclear Accidents"

Panel Discussion – Chair: *Prof. Benedict D. Rogers* (The University of Manchester, United Kingdom), **Panel Members: *Prof. Peter Eberhard*** (Institute of Engineering and Computational Mechanics, University of Stuttgart, Germany), ***Prof. Eung Soo Kim*** (Department of Nuclear Engineering, Seoul National University, South Korea), ***Dr Bonaventura Tagliafierro*** (The Universitat Politècnica de Catalunya, Spain and University of Wisconsin-Madison, USA), ***Ms Yaru Ren*** (Sichuan University, China and Technical University of Munich, Germany)
10:25 – 11:00 UTC
"SPH & Industry – current status and future perspectives"

Closing Remarks by *Prof. Prapanch Nair* (Indian Institute of Technology Delhi, India)
11:00 – 11:10 UTC

During the panel discussion, at first the panel chair, Prof. Benedict D. Rogers, presented a general outline of the panel discussion including 4 core questions. Then panellists were invited to discuss and share their vision on these core questions, and followed by that a few other participants also shared their viewpoint. The 4 core questions of the panel discussion were as follows:

I. What is the current state-of-the-art related to SPH applications in industry? And why SPH was chosen for those applications instead of other computational methods?

II. What is preventing more industrial companies from adopting SPH and what can we do to reduce the barrier to more widespread use?

III. At this moment, what does SPH NOT do that industry need/want? Where should the research effort of universities be directed?

IV. What are the key crucial and specific steps for establishment of SPH as a reliable computational method for challenging industrial applications that the current computational technology is difficult to achieve?

During the panel discussion the challenges as well as future perspectives corresponding to continued development of SPH for industrial applications were actively discussed. In brief, panellists highlighted the need for systematic efforts by the SPH community to enhance the versatility of SPH for industrial applications, especially, for applications that SPH is intrinsically well-suited and potentially advantageous. In this regard, rigorous validations should be considered as a primary step and then the capability of SPH in providing right solutions to the right problems need to be well portrayed. We need to systematically prove that SPH can not only provide right solutions to the relevant industrial problems with respect to established computational methods, but more importantly, what SPH can achieve more conveniently and reliably with respect to other computational methods that industry has been relying on for years. The panel also highlighted the importance of motivating young researchers and scholars in contributing to the continued development of SPH for industrial applications through rigorous and systematic academic research. The workshop was concisely and informatively concluded by Prof. Prapanch Nair. A recorded video of SPH Online V is available on YouTube.

The award selection committee of the workshop evaluated all the talks and with respect to their evaluation, the Best Presentation Award was presented to **Dr Jean-Christophe Marongiu**. The members of award selection committee included **Prof. Damien Violeau** (EDF, LHSV, Ecole des Ponts ParisTech, Ecole Normale Supérieure de Paris-Saclay, France), **Prof. Antonio J. Gil** (Zienkiewicz Centre for Computational Engineering, Swansea University, The United Kingdom), **Dr Corrado Altomare** (Universitat Politècnica de Catalunya – BarcelonaTech UPC, Spain), and the organisers, i.e., the authors of this article. SPH Online is an SPHERIC-affiliated event, and we look forward to organising **SPH Online VI** in 2024 (likely in September or October 2024). The exact date and focus topic will be announced later.

Some of the participants of SPH Online V

Fruitless Efforts for a Vector Potential Implementation of SPMHD

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Magnetic fields are dynamically relevant for many areas of astrophysics, thus including their effect in simulations is important. Given that SPH is used extensively within astrophysics, there is therefore a need for SPH solvers that include the effects of magnetic fields.

Smoothed particle magnetohydrodynamics (SPMHD) couples SPH with magnetic fields to simulate plasmas, and robust SPMHD solvers have been developed that have been used to study a wide range of astrophysical applications. However, magnetic fields have important topological constraints, that is, magnetic fields are purely solenoidal. This divergence-free constraint is only approximately upheld in current state-of-the-art SPMHD methods.

In many ways, modelling magnetic fields in SPH is similar to modelling incompressible fluids. For an incompressible fluid, the divergence of the velocity fluid is zero. Weakly compressible SPH sacrifices some degree of fidelity in exchange for a computationally inexpensive and simple method, and this works in practice for many problems. But there are also classes of problems where true incompressibility is important to model. For SPMHD, divergence cleaning [1] is an approximate method that is cheap, simple, and sufficient for many problems. However, achieving a truly divergence-free magnetic field also remains important. In SPMHD, however, a robust method to exactly preserve the divergence-free constraint on the magnetic field does not currently exist.

In this work, we investigated use of the vector potential as the basis to uphold the divergence-free constraint on the magnetic field in SPMHD. With this approach, the magnetic field is defined as the curl of the vector potential. The divergence of the curl is zero. This would then guarantee a magnetic field that numerically evolves in a divergence-free manner. Price [2] constructed a vector potential SPMHD formulation based on the induction equation written in terms of the vector potential. This was found to be plagued with numerical instabilities.

Our approach here is to express the continuum equation in integral form instead of differential form. The resultant discretization is the same as the Price [2] formulation, but with an extra correction term. Our hope was that this might sidestep some of the numerical instabilities found in the previous discretization.

Unfortunately, the discretization obtained through the volume integral-based formulation retains all of the numerical instabilities present in

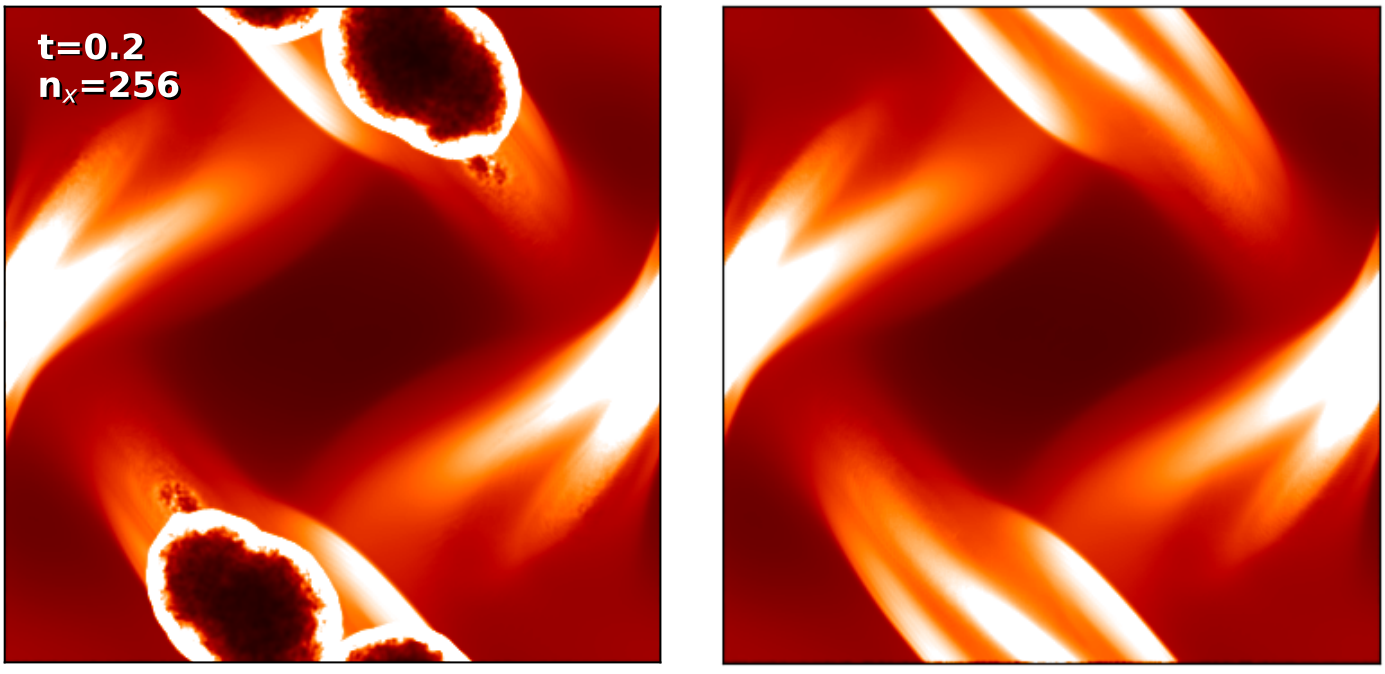


Fig. 1: The Orszag-Tang vortex with the new vector potential formulation (left) compared with direct evolution of the magnetic field (right; standard SPMHD). Large density voids appear in the vector potential implementation due to runaway energy growth caused by numerical instability.

the Price [2] formulation. Figure 1 shows an example from the Orszag-Tang vortex test, whereby the new vector potential formulation undergoes exponential amplification of magnetic energy, leading to large density voids. This occurs in the exact same manner as the Price [2] formulation, thus the new correction term does not alleviate this numerical issue.

One important consideration, however, is the choice of momentum equation that is used in conjunction with the equation for the time evolution of the vector potential. In Figure 1, accelerations are calculated via the momentum equation expressed in terms of the magnetic field. The magnetic field is reconstructed from the vector potential. This seems innocuous, but it means there is a mismatch of variables between how the magnetic field is evolved (via the vector potential) and how accelerations are calculated (via the reconstructed magnetic field). This leads to non-conservation of energy.

In principle, a fully conservative formulation can be created by expressing the momentum equation directly in terms of the vector potential. Price [2] derived this formulation, but it contains a number of significant numerical issues that means this approach is not viable in practice.

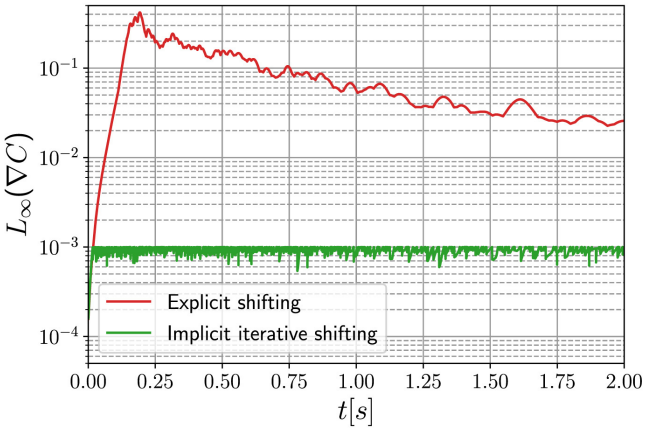
These underlying numerical issues are not resolved by deriving the momentum equation from the new volume integral formulation developed in this work. Doing so yields the same momentum equation as the Price [2] formulation, but with an extra term. Aside from retaining the numerical issues inherent to the existing terms, this new formulation also means that the momentum equation that is obtained does not even fundamentally solve the MHD equations of motion.

Overall, a new implementation of the vector potential in SPMHD was investigated. The approach taken was to express the induction equation in integral form, which leads to a novel discretization. However, this does not solve numerical issues that were encountered in previous attempts to derive a vector potential implementation, and the fully conservative system of equations using this discretization do not even correctly represent the continuum equations. One step forward, two steps backward.

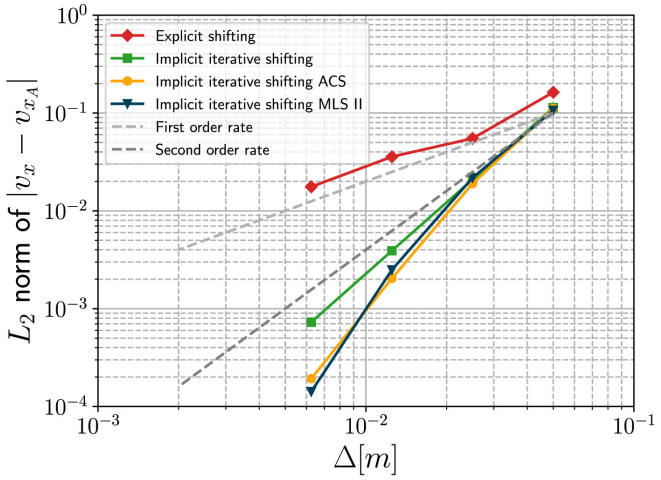
References

[1] T. Tricco and D. J. Price (2012) Constrained hyperbolic divergence cleaning for smoothed particle magnetohydrodynamics. Journal of Computational Physics, 231, 7214-7236.

[2] D. J. Price (2010) Smoothed particle magnetohydrodynamics–IV. Using the vector potential. Monthly Notices of the Royal Astronomical Society, 401(3), 1475-1499.



(a) $L_\infty(\nabla C)$ obtained with the IIPS and explicit shifting for $\Delta/L = 0.00625$



(b) Convergence analysis $L_2|\boldsymbol{v}_x - \boldsymbol{v}_{xA}|$, implicit particle shifting comparison at $t = 1s$.

Two new actions by the SPHERIC Steering Committee

Establishment of the SPHERIC Scientific Committee and preparation of a "Guide for Reviewers of SPH Manuscripts"

Abbas Khayyer, Renato Vacondio, Benedict Rogers

Followed by its development in 1977 and more than four decades of continued efforts by a great number of researchers in different fields of science and engineering, nowadays SPH holds an increasing reputation as a robust, versatile computational method. Certainly, there are still many aspects, including the so-called SPH Grand Challenges, that need to be more rigorously studied and addressed for a better establishment of SPH and its thoroughly reliable application in science and engineering. In addition, due to its robustness, flexibility and potential reliability, application areas of SPH have been constantly increasing. Nowadays SPH is not only applied for astrophysics or fluid mechanics, but also structural mechanics, geomechanics, biomechanics, aerospace engineering, manufacturing engineering, etc. In this regard, the SPHERIC steering committee decided to take two specific actions to promote continued rigorous and reliable developments of SPH and at the same time ensure that the reputation of SPH will not be possibly damaged by papers that may contain misleading or unreliable information. These two recent actions by the SPHERIC steering committee include:

1. Establishment of the SPHERIC Scientific Committee

Followed by a series of discussions, the SPHERIC steering committee decided to list and then invite internationally reputable and active SPH researchers in a wide range of science and engineering fields to form the SPHERIC scientific committee. The members of this committee are actively involved in pushing the advance and development of SPH and as long as their time permits, they actively and responsibly review SPH manuscripts submitted to international journals to ensure reliable developments based on academic rigour and standards. The list of members of this committee is now published on the SPHERIC official website at

https://www.spheric-sph.org/scientific-committee

Header image: an example of convergence analysis in SPH.. Credit: P.Rastelli, R.Vacondio, J.C.Marangiou, "An arbitrarily Lagrangian–Eulerian SPH scheme with implicit iterative particle shifting procedure", Computer Methods in Applied Mechanics and Engineering, 414 (1), 2023, doi:10.1016/j.cma.2023.116159

2. Preparation of a 'Guide for Reviewers of SPH Manuscripts'

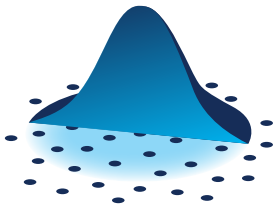
The SPHERIC steering committee also had series of discussions to prepare a concise and comprehensive guide on review of SPH papers. This guide has now been prepared and published on the SPHERIC official website at:

https://www.spheric-sph.org/sph-reviews

A concise description of this guide is as follows.

In general, SPH papers can be divided into three main categories of i) theoretical analyses, ii) new/enhanced schemes, iii) new industrial/engineering applications. For the sake of brevity, in the document of 'Guide for Reviewers of SPH Manuscripts', "analysis", "scheme", and "application", are used to refer to the categories one to three mentioned above. Nine aspects are suggested to be considered in review of SPH papers: 1) Novelty, 2) Significance, 3) Rigorousness, 4) Validity and Reliability, 5) Computational Performance, 6) Generality, 7) Scrupulousness, 8) Clarity and Conciseness, and 9) Future Perspectives. For each aspect a set of related questions are suggested to be considered, if applicable.

This guide will be helpful not only for reviewers of SPH manuscripts, but equally to the SPH researchers, especially young researchers who have just started to conduct their research in the field of SPH. The guide will hopefully help researchers to present their contribution and publish their results in form of papers that will be of "permanent scientific value", advancing the state-of-the-art of SPH, and potentially lead to new directions in SPH developments and applications.



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NEWSLETTER

SPH rEsearch and engineeRing International Community

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