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Comment

Comment on Mahariq et al. Investigation and Analysis of Acoustojets by Spectral Element Method. *Mathematics* 2022, *10*, 3145

Igor V. Minin * and Oleg V. Minin

Nondestructive School, National Research Tomsk Polytechnic University, Lenin Ave, 30, 634050 Tomsk, Russia
* Correspondence: ivminin@tpu.ru

Abstract: The paper under discussion has some shortcomings in regard to mathematical formulation of the problem related to acoustics, its justification, some references analyses and the text, and we feel that this study has not been finished to its full extent. From the point of view of acoustic jet formation, the mathematical model used by the authors has a number of significant limitations which are not taken into account. Moreover, the formal analogy between the parameters of electromagnetic waves and acoustic waves should be used with caution in the conditions of localized beams (acoustic jet), and the limits of their application should be justified.

Keywords: acoustic jet; acoustojet; mesotronics; spectral method

MSC: 35J05

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According to the title, abstract and paper conclusion, the authors based a study of acoustic wave scattering with Helmholtz equations with a penetrable sphere and the formation of so-called acoustic jets in a homogeneous media by the spectral element method [1]. This is an interesting study, and the authors describe the spectral method well. However, in our opinion the paper has some shortcomings in regard to mathematical formulation of the problem in relation to acoustics, its justification, some references analyses and the text, and we feel that this study has not been finished to its full extent.

In paragraph "4. Results and Discussion" the authors claim that "Another critical parameter, m, is defined by the index ratio of sphere and surrounding medium, . . . , which directly affects the speed of sound ratio". Additionally, all their further reasoning is therefore based on the effective refractive index. However, since the article is devoted to an acoustic jet, the authors should use the terms from acoustics instead of those from optics and electromagnetic waves—for example, "the averaged pressure", "acoustic impedance" and "volume velocity fields", etc. [2–4].

It should be mentioned that electromagnetic waves and sound (acoustic) waves are two different types of waves [5,6]. Acoustic waves have *vector particle velocity* and do not have polarization. Electromagnetic waves are transverse, in contrast to sound waves which are longitudinal. Moreover, in common cases acoustic waves have two sound propagation speeds (*longitudinal and shear*) which are well known [7–9]. Therefore, solids, including dielectrics, are intrinsically anisotropic in acoustics, in contrast to their state in electromagnetic waves, where they are isotropic. Despite this, the authors noted in page 6 that " . . . the spherical lens could be realized . . . as . . . steel and lead . . . " and used an isotropic model.

Of course, as it was shown in [10], in some cases this can be stated formally, based on the analogy between the equations, specifying electromagnetic wave and acoustic processes—see Ref. [10] and references there. However, even for liquids and gases, where there is no shear sound speed, the analogy with the effective refractive index in the case

of an acoustic jet (highly localized acoustic beams) is not fulfilled (because the effective refractive index depends not only on the relative speed of sounds, but also, for example, on the density), which was shown in [11,12]. Consequently, the results obtained by the authors are certainly valid for electromagnetic fields and optics, but their applicability to acoustic jets is not substantiated.

Minor comments:

The authors wrote that "Since their first proposal in 2004, photonic nanojets have been studied intensely in recent years [1]". Until now, the question of the discoverer of the photonic jet (nanojet) effect is still being discussed. In Ref. [1] (Ref. [13] here), the term "photonic nanojet" was introduced for the first time, but the effect has been described before. Many articles have been published on the subject, which, if required, are easy to find.

Furthermore, the authors claim that "In analogy to the nanojet effect, subwavelength beam localization is also possible for acoustic and ultrasound fields, which is termed as "acoustic jets" or "acoustojets" [4–10]". This is not correct. In references [4–7] (Refs. [14–17] here), the terms "acoustic jets" or "acoustojets" *were not mentioned*. In references [8,9] in [1] (Refs. [18,19] here) the effect of an acoustic hook is discussed, which differs fundamentally from an acoustic jet.

In regard to the following sentences from the paper: "is termed as "acoustic jets" or "acoustojets" [4–10]" (Refs. [14–19] here), the term "acoustojet" was introduced in Ref. [10], and it was not even mentioned in Refs. [4–7] in [1]. The question is, therefore, why did the authors credit the invention of acoustojets and acoustic jets to references [4–7] in [1], when they know very well that these terms were first introduced in [10]? Moreover, Ref. [14], for example, was published online on 18 May 2017, while Ref. [10]—published online on 11 January 2017 with priority of arXiv:1604.08146 from 25 April 2016 (see Ref. [10]).

The authors also wrote that "In Ref. [17] (Ref. [20] here), the apparatus was prepared and studied in relation to the practical mission of powder spraying to generate the jet by a low frequency resource of a vibration-resonance type. In Ref. [18] (Ref. [21] here), the jets were formed as a product of the propagation of intensive sound through a small hole in a screen placed in the cross section of the waveguide". One could mention that Refs. [20,21] deal with so-called a *Synthetic Jet*, which by its nature has nothing to do with the acoustic jet [22].

The authors claim that "It is possible to analyze the acoustic plane wave scattering by using the spectral element method" without any references. It would be correct to refer to some papers, for example, to DOI: 10.1016/0168-874X(94)90076-0, etc. A brief review of the spectral methods given by the authors looks somewhat chaotic, since the study presents confusion about acoustics and electromagnetic waves is mixed, but these are different types of waves in their physical nature.

Additionally, the authors wrote that "Another important finding is simultaneous existence of whispering gallery modes (WGMs) with acoustic jet, which *has not been reported before* in acoustic jet studies". We may refer, for example, to [23,24].

In general, the acoustic model of the phenomenon under consideration, the acoustic model of the scatterer (isotropic, anisotropic, relation between longitudinal and shear speed of sounds [25–31], etc.), and how the result obtained can be correctly applied to describe the acoustic jet phenomenon are not clear from the article under discussion. It seems that the authors of the article do not deeply understand the difference between the nature of electromagnetic and acoustic waves. A formal analogy between the parameters of electromagnetic waves and acoustic waves and the limits of their applicability must be justified. The article does not show the applicability of the results obtained specifically to acoustic waves, even though this is precisely the purpose of the study.

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