

# GLOBAL ELECTROPHONIC FIREBALL SURVEY

D. Vinković<sup>1</sup>, Ž. Andreić<sup>2</sup>, S. Garaj<sup>3</sup>, D. Kovačić<sup>4</sup>, M. Mladinović<sup>5</sup>, G. Zgrablić<sup>5</sup>

<sup>1</sup>Department of Physics and Astronomy, University of Kentucky, Lexington, KY 40506-0055, USA

E-mail: dejan@pa.uky.edu

<sup>2</sup>Rudjer Bošković Institute, Department of Materials Science, Thin Films Laboratory  
Bijenička 54, 10000 Zagreb, CROATIA

<sup>3</sup>I.G.A. – Departement de Physique, École Polytechnique Fédérale de Lausanne  
CH-1015 Lausanne – EPFL, SWITZERLAND

<sup>4</sup>Cognitive Neuroscience Sector, International School for Advanced Studies, SISSA  
via Beirut 2-4, 34014 Trieste, ITALY

<sup>5</sup>Department of Physics, Faculty of Science, University of Zagreb, Bijenička 32, 10000 Zagreb, CROATIA

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## Abstract

The electrophonic sound from a meteor is a rare, mysterious, and poorly understood natural phenomenon. Investigations done so far suggest the ELF/VLF radio waves as a source of this sound, but many other questions about the ELF/VLF emission and its transformation into the sound lack satisfactory explanation. Thus it is not surprising that most of our knowledge about the phenomenon is still based on eyewitness reports. The purpose of the *Global Electrophonic Fireball Survey* (GEFS), (accessible at <http://gefs.ccs.uky.edu>), is to collect these reports and provide a more systematic approach in the study of this phenomenon with a possibility for more extended activities. Due to the rareness of these sounds, contributions from the experienced meteor observers are essential for this study.

## 1 Introduction

Very bright meteors, (fireballs), are sometimes accompanied by sounds heard simultaneously with their passage. A large distance to the meteors and limited speed of sound suggest that these simultaneous sounds can not be explained by ordinary sound propagation. The ordinary sound from a meteor, (sonic boom), travels a few minutes before it arrives to an observer on the ground.

On the other hand, simultaneous (or anomalous or electrophonic) sounds require propagation with the speed of light, which suggests that they are actually electromagnetic waves transformed somehow into sound in the vicinity of the observer.

It is amazing that, even though the physical distinction between the ordinary and anomalous sounds was recognized more than three hundred years ago [1], we are still lacking a satisfactory explanation of the phenomenon of electrophonic sounds. In the 20th century, a number of theories have emerged [2, 3, 4], but all of them either fail to explain the variety of the electrophonic sound properties or have serious physical shortcomings.

Nevertheless, the current widely accepted theory says that the electrophonic sounds are created by the ELF/VLF radio waves [5] emitted from a meteor [4]. It has been shown in the laboratory experiments [4, 6] that the ELF/VLF electric fields are capable of producing the sound but the overall problem remains since we still have to explain how it is possible for a meteor to create such a strong ELF/VLF emission. The usually invoked explanation of this emission [4, 7] requires physical parameters which are very often not fulfilled by the electrophonic fireballs [8].

As we can see, there are many open questions in the study of electrophonic fireballs. It is not clear how meteors can produce a strong ELF/VLF emission and what are the limiting factors in this process, how exactly the sound can be generated by the ELF/VLF radio waves and thus we do not know if some specific weather conditions or objects are more favorable for electrophonic sound detection.

## 2 Where and how to report an electrophonic sound

There have already been some activities within the *International Meteor Organization* (IMO) related to these issues [9], including an electrophonic catalog by C.S.L.Keay [10]. IMO can have substantial influence on the study and promotion of this phenomenon. This is due to its members, experienced meteor observers from all over the world, and due to the *IMO Fireball Data Center* (FIDAC), which has become a major source in studies of the physical parameters of fireballs.

Fireballs are quite a rare event and just a fraction of them will yield electrophonic reports. Thus it is important to have in mind that all possible electrophonic reports are very valuable. Since our knowledge about electrophonic sounds is very limited and mostly based on eyewitness reports, it would be very useful for any future work in this field if the reports are collected in a systematic and unique way. This was the motivation for introducing the *Global Electrophonic Fireball Survey* (GEFS) by the Center for Computational Sciences at the University of Kentucky. The initial purpose of GEFS is collecting eyewitness reports of electrophonic sounds from meteors, with the possibility of extended research efforts in the future.

The reports are collected via an HTML data submission form from the website:

[http://gefs.ccs.uky.edu/GEFS\\_Form.html](http://gefs.ccs.uky.edu/GEFS_Form.html)

or by e-mail to: [gefs@ccs.uky.edu](mailto:gefs@ccs.uky.edu)

or by ordinary mail, (see the form at the end of this text), to the following address:

Global Electrophonic Fireball Survey  
University of Kentucky  
325 McVey Hall (CCS)  
Lexington, KY 40506-0045  
USA

Some additional informations and references related to electrophonic sounds can be found on the GEFS homepage <http://gefs.ccs.uky.edu>.

It is important to emphasize that even simple reports with specified month and year of an electrophonic sound event are already valuable. In this case, we can look for correlation between the months during a year and rate of electrophonic appearance, or we can assume to which meteor shower the observed meteor belongs. That gives us the meteor's properties, and we can check if one type of meteor is more efficient in the production of electrophonic sound than another. Nevertheless, the observer should provide as much detail about the event as possible.

The form has four parts. They are dealing with the contact information about the observer, description of the place where the observer heard the sound, specifics of the sound that the observer heard, and the meteor which produced the sound:

**Personal information** — It will be asked that the observer specify name and contact information, and give some information about his or her meteor observation experience.

**Description of the observing site** — It will be asked that the observer provide the location of the place where the sound was heard as precisely as possible; describe in detail the observing site, including the meteorological conditions at the moment of the electrophonic event; describe also the outlook and objects around the observer, since this could be important for the generation of the sound; and describe everything that is found unusual about the site.

**Details about the electrophonic sound** — It will be asked that the observer specify the date and time of the electrophonic observation as precisely as possible; describe the sound, its duration, and possible direction from which it came; if the observer was not alone, specify how many people were there and how many of them also heard the sound; and if the meteor that could be the source of that sound was sighted, describe the moment when the sound was heard relative to the meteor light maximum.

**Details about the meteor** — It will be asked that the observer provide as much information about the meteor as possible, how fast it was, color, fragmentation, duration, and position on the sky;

All data collected by GEFS will be made public through the GEFS internet site, WGN, and special newsletters, with full reference to witnesses.

It is important to spread the awareness about this phenomenon, since people have the tendency to ignore it due to the sound experiences in their daily life. The man-made noises have probably masked many electrophonic sounds during modern times, and people do not find these sounds unusual any more. Thus it is not surprising that we can find some of the most detailed descriptions of the electrophonic sounds in more than 200 year old manuscripts, but we are still tumbling in their explanation.

## References

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## Global Electrophonic Fireball Survey: Data Submission Form

It is not necessary to fill out the form completely. Just provide as much information as you can remember or have available.

If you are not sure in the exactness of your data, skip it or mention this as a comment at the end of this form.

### Personal information

First name, middle name(s) initials, last name <sup>1</sup>	
Address <sup>2</sup>	
Country	
Phone number <sup>2</sup>	
E-mail <sup>2</sup>	
Level of the meteor observing experience	<input type="checkbox"/> not experienced <input type="checkbox"/> somewhat experienced <input type="checkbox"/> moderately experienced <input type="checkbox"/> highly experienced
Have you ever heard a sound from a meteor before?	<input type="checkbox"/> NO <input type="checkbox"/> YES

<sup>1</sup> This information will be publicly available ONLY with your approval; see end of this form

<sup>2</sup> This information will NOT be publicly available

### Description of the observing site

Location of the observing site	general description:
(give exact coordinates, if known)	longitude:                      latitude:                      elevation:
Describe in detail the meteorological conditions at your observing site (temperature, humidity, wind, rain, clouds, etc...)	
Describe in detail your observing site (vegetation, buildings, fences and—especially—any metal objects in your vicinity, etc...)	
Describe in detail your outlook and clothing during observation (especially important is your haircut, glasses and metal objects)	



**Details about the meteor**

(if you have seen or detected the meteor)

Meteor shower (or sporadic)	
Meteor magnitude	
Velocity (enter the exact value if known) ___ very slow    ___ slow    ___ fast    ___ very fast    ___ static    (_____ km/s)	
Color	
Fragmentation	___ NO                    ___ YES
Duration	
Height above horizon (from 0° to 90°)	
Azimuth (from 0° to 360°) (N=0°, E=90°, S=180°, W=270°)	
Angle between the meteor path and horizon (from 0° to 90°)	

**Additional remarks**

At the end, we would like to thank you for your patience and cooperation. If you have any additional comments, remarks, or suggestions, please mention them here.

With submitting this form you agree to make your report public.

Do you agree to use your name as a public reference to the data that you are submitting?

(If you mark nothing or both, it will be assumed that you agree.)

\_\_\_ YES                    \_\_\_ NO

Your address and e-mail will not be made public, and we will keep it only for the purpose of gathering additional information from you.