“QUANTUM PHYSICS OF A SOUND, RESPECTIVELY PHYSICS OF PRESSURED OSCILLATIONS OF QUANTICLES CALLED “PHONONS““

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Abstract: This Tech–Science text of article dedicated to the QUANTUM ACOUSTIC Sensu Stricto says about phonons, the sound quazi–particles elements, which are very interesting in nano, micro, makro scales of nature.
This New Concept of QUANTUM ACOUSTIC PHYSICS OR QUANTUM PHYSICS OF SOUND IS ILLUSTRATED ON EMPIRIO–CRITICISM PHILOSOPHY OF EXPERIMENTAL PHYSICS OF MORAVIAN BORN PROFESSOR ERNST MACH, the text operated with subjects like MACH’S NUMBER, MACH’S CONE, MACH’S PRINCIPLE, MACH’S WAVEMACHINE. The Highlights is focused on Author’s Sketches in problematic connected with AERODYNAMICS AND AERONAUTICS.

Keywords: E. Mach, Mach’s cone, Mach’s number, phonons, oscillations, acoustic bang, supersonic bang (boom).

Contents

1. Introduction

The nature and condition of a spreading a sound were discovered on hand in hand with development of planes engineering high tech supersonic technologies (electronic fly–by–wire), stealth technology, for example jet plane X–35 joint strike fighter, F–22 Raptor, F–15 EAGLE, Su–57, Chengdu J–20.

The sound has a great importance to “easy human communication” and also in supersonic travelling in stratosphere, and also for leading of infowar, from somehow high–tech country in the whole world.

From an angle of sight of Standard Model is very important inclusion of phonons into the Standard Model families.

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2. Sketches of highlights

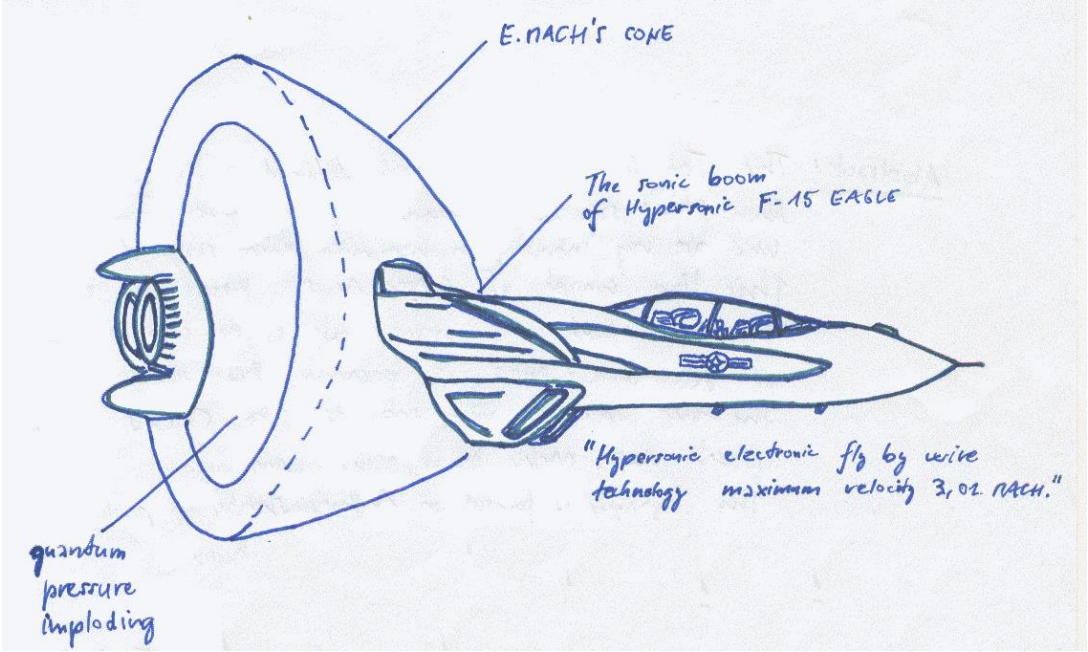

Fig. 1. The Sonic Boom of Supersonic F–15 EAGLE respectively Supersonic Bang Ernst MACH'S CONE, during the pressure high and termic barriers. Author of the sketch: Imrich KRIŠTOF, M.Sc..

Comment 1: **ERNST MACH** physicist

Was an Austrian–Moravian theoretic physicist, philosopher, dean of university.
*18.2.1838 Chrlice u Brna, MORAVA, Austrian Imperium
+19.2.1916 Vaterstetten, German Imperium
Known for MACH PRINCIPLE, MACH WAVEMACHINE, MACH PENDULUM, MACH'S CONE, MACH'S NUMBER.

The Main Elements of creation of MACH'S CONE is the profile of the WAVE AND VELOCITY OF FLYING OBJECTS (SUPERSONIC VELOCITY). ALWAYS IS IMPORTANCE FOCUSED ON CLIMATOLOGICAL CHARAKTERISTICS OF ATMOSPHERE LIKE HYDRIC CONDITIONS, ATMOSPHERIC PRESSURE, THERMODYNAMIC CONDITIONS –

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IZOTERMIC, IZOBARIC AND ADIABATIC PROCESSES OF “IDEAL GAS”, AND DEPENDENT ON ALTITUDE OF PLANE.

RESISTANCE ENVIRONMENT NEWTON FORCE OF SURROUNDINGS

Profile of wing: $F = \frac{1}{2}\rho S v^2$

Program x–foil: $F = \frac{1}{2} C_x \rho S v^2$.

Airfoil examples:

MACH’S NUMBER resp. Reynolds number viscosity liquid:
subsonic M < 1, sonic M = 1, M > 1 supersonic ultrasonic velocity.

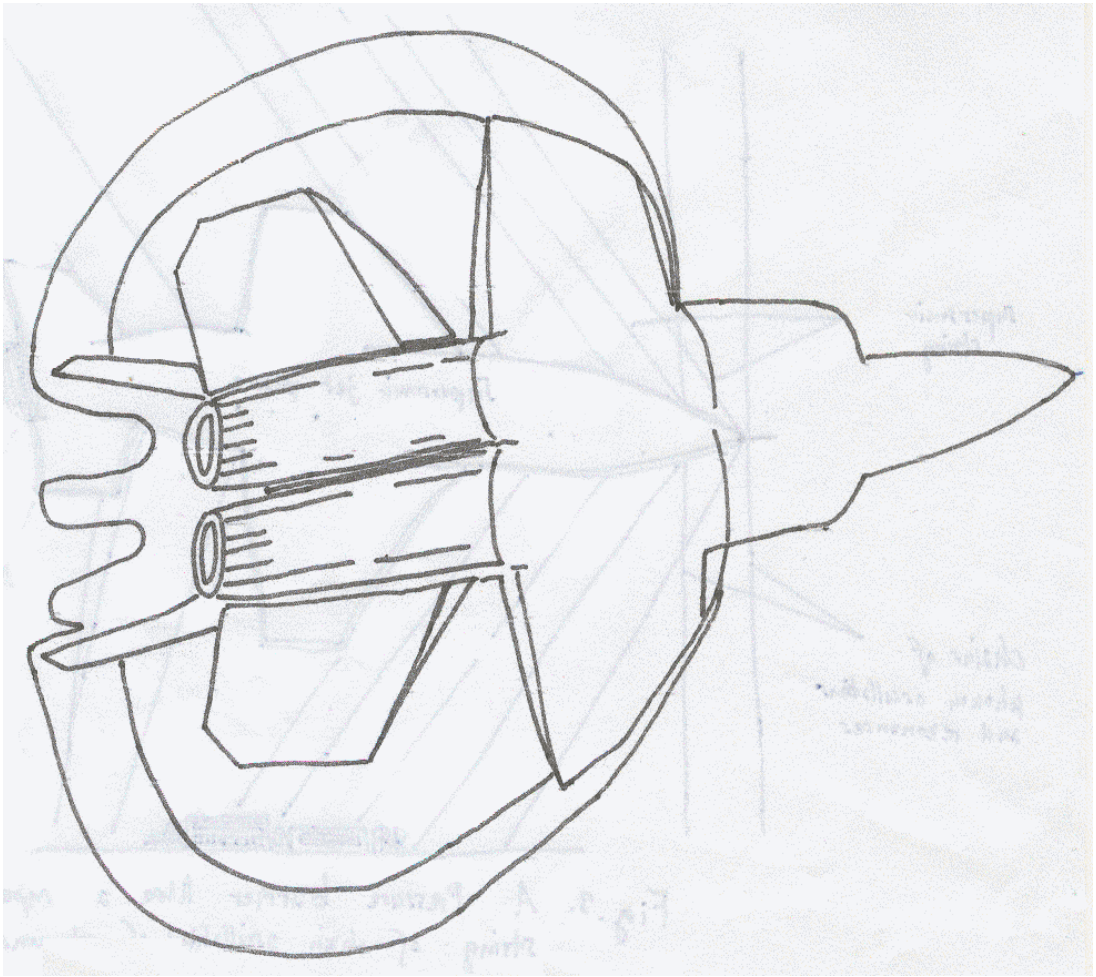

Fig. 2. F–15 EAGLE in Supersonic “imploding hat” the pressure velocity barrier accurately 1200 km/h = 1,2 MACH Author of the sketch: Imrich KRIŠTOF, M.Sc.

27.12.2018, Brno

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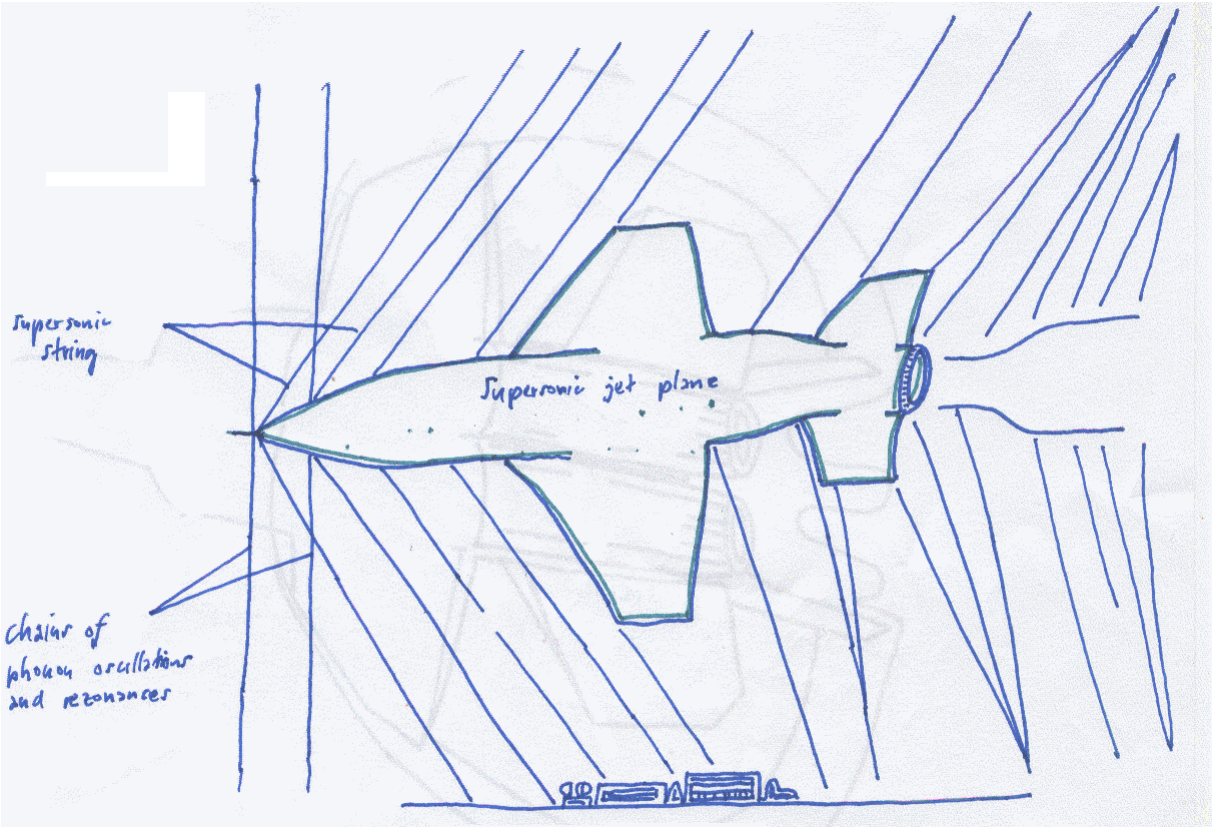

Fig. 2. A Pressure barrier like a supersonic string of chain oscillations of phonons may disrupt Architectonical stability structure of cities buildings. The velocity of a sound has a value about 340 meters per a second (resp. 1224 km per a hour). Author: I. KRIŠTOF, M.Sc.

3. Theory of Phonons

Comment 2: **PHONONS – QUAZIPARTICLES OF A SOUND**

Thermal Properties of a solid compound (crystal) lattice, thermal equilibrium can be derived from the free energy. Phonon frequencies – all phonons calculations will be found using the harmonic approximation of interatomic distances. **Spin of photons** is ①, **QUASIPARTICLE PHONON CARRIES ZERO SPIN** ⓪, BECAUSE A PHONON IS A QUANTUM OF "SOUND" AND "SOUND" IS A **LONGITUDINAL WAVE**.

Phonon dispersion relations are calculated by looking for wavelike solutions to the **classical equations of motion** of atoms **under** a small **displacement** from their **equilibrium sites**.

Comment 3: In Physics, a phonon is a complex excitation in a periodic, elastic arrangement of atoms or molecules in condensed matter.

Phonon Scattering – Phonons can scatter through several mechanisms, as they travel through the material:

· **UMKPLAPP PHONON–PHONON SCATTERING**
· **PHONON–IMPURITY SCATTERING**
· **PHONON–ELECTRON SCATTERING**
· **PHONON BOUNDARY SCATTERING**

EACH SCATTERING MECHANISM CAN BE CHARACTERIZED BY A RELAXATION RATE $1/\tau$ WHICH IS THE INVERSE OF THE CORRESPONDING RELAXATION TIME.

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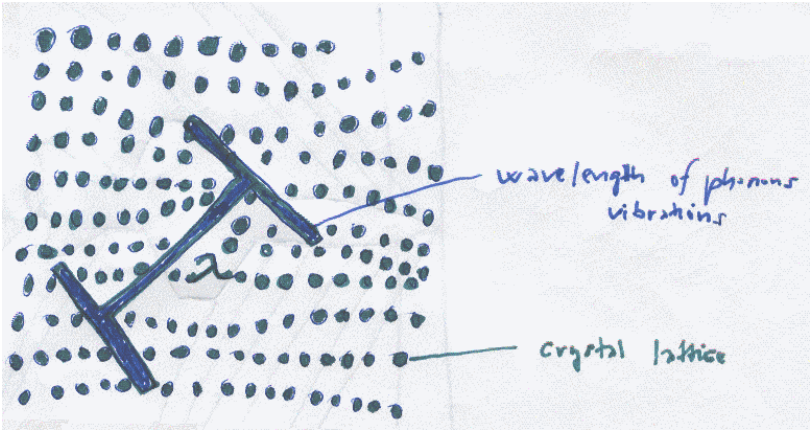


Fig. 4. Ilustration of phonons (quasiparticle spreading of vibration quantum in crystal lattice).
Author of the Sketch: Imrich KRIŠTOF, M.Sc.

Significance of a sound is concentrated in spreading of sound in a space, including almost of interactive changing of sound information or sound signals. For example has recepted sound in interval from **16 Hz till 20 000 Hz**, in vacuum sound doesn't spread.

The most signifikance is could offer: "IS A PHONON ASSOCIATED IN SO CALLED STANDARD MODEL WITH NEUTRINOS OR OTHER LEPTONIC PARTICLES:" ????
HAS PHONONS HAVE A NEGATIVE MASS?

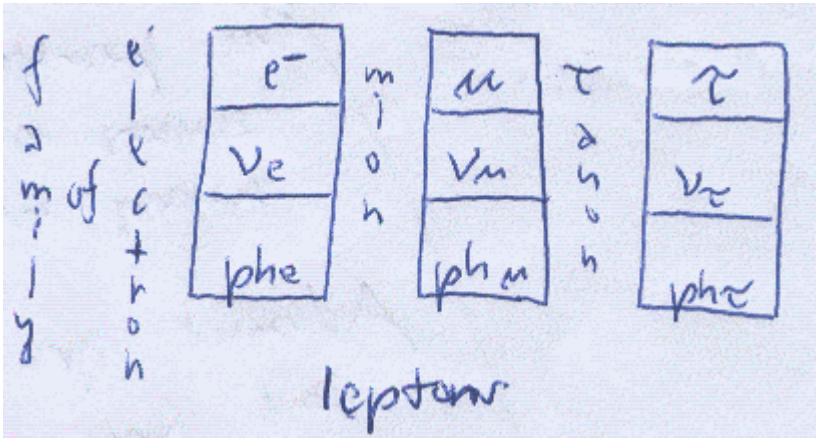


Fig. 5. Theoretical illustration of leptons and phonons. Author of the sketch: Imrich KRIŠTOF, M.Sc.

Effects of impurity recoil, solves an extended Fröhlich Hamiltonian for an impurity in a Bose gas and accurately reproduces the observed excitation spectrum.

Comment 4: All phonon scattering processes can be taken into account using **Mattheiessey's rule:** The combined relaxation time τ_C can be written as:

$$\frac{1}{\tau_C} = \frac{1}{\tau_U} + \frac{1}{\tau_M} + \frac{1}{\tau_B} + \frac{1}{\tau_{ph-e}}$$

The parameters τ_U, τ_M, τ_B, τ_{ph-e} are due to Umklapp scattering, mass–diference impurity scattering, boundary scattering, and phonon–electron scattering.

Advanced type of a **scattering oscillations** is Three-phonon and four–phonon process.

The amplitude of the optical phonon oscillation as a function of temperature for x = 0.5 open circle and x = 0.58 solid circle (chain of oscillating phonons).

OPTICAL PHONON GENERATION, THE CORRESPONDING OPTICAL PHONON MODE SHOULD SHOW UP IN CONVENTIONAL **RAMAN SPECTRA.**

JAHN TELLER DISTORTION A SUPERSTRUCTURE OF THE CUBIC PEROVSKIT STRUCTURE 0.5 Ca 0.5 MnO_3 STUDIED BY X-RAY DIFFRACTION.

Comment 5: **Chandrasekhara Venkata Raman**
*7.11.1888 Tiruччiráppalli – 21.11.1970 Bengalúru
Indic physicist, Nobel Prize For Physics Winner in 1930 for dispersion of light and for discovery, so–called Raman phenomena spektra.

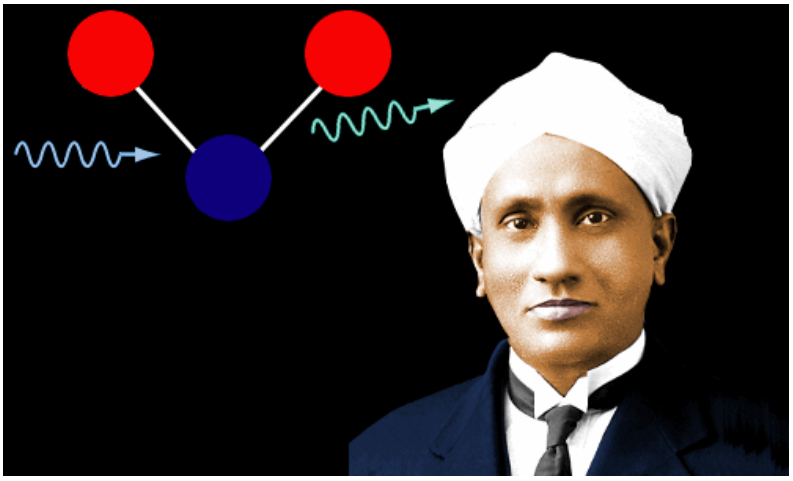


PHOTO OF C. V. RAMAN

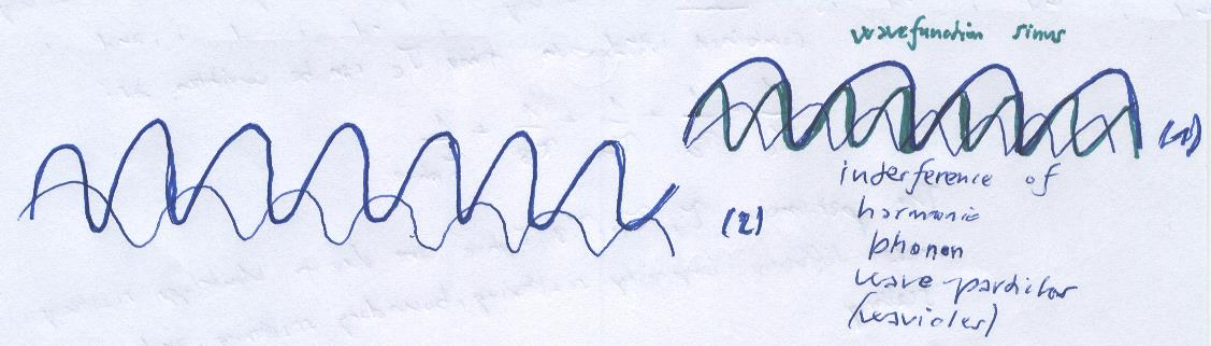
Edvard Teller

"architect of STAR WARS"
Hungarian–American nuclear physicist "father of H–bomb"
*15.1.1908 Budapest – 9.9.2003 Stanford, California, U.S.A.

PHOTO OF E. TELLER

Euphonia – "the sound of Spheres, harmonic oscillations of phonon particle–wave, harmonic resonances of chain of phonons (1).

Kakophonia – disharmonic sound oscillation, disharmonic dissonances (2).



4. Conclusion

The using of oscillations of quasiparticles phonons have wide interdisciplinary spreading, respectively physicist basic context in MUSIC (ACOUSTIC PHYSICS), GEOPHYSICS – geophones – small detectors of vibrations of soil or rocks (lithospheric crust of Earth) in prospect engineering (exploration) of gas and oil in the centre of plateau and synclinales of continents – **Great Hungarian Plateau** – NAGY ALFÖLD, KIS ALFÖLD, synclinale Dolnomoravská – LANŽHOT – BŘECLAV (GAS OIL LOCALITIES), synclinales of Nezider See in Austria, DANUBIAN LOWLAND, geomorfological subprovince of Westpanonic Plain (tectonic basin).

Astrophysics – Astro–scientists can measure the STARSEISMIC ACTIVITY without anyhow sound.

USE IN COSMIC–FLIGHT, IN (SPACE–FLIGHT) AND SUPERSONIC AIR DIVISIONS OF HIGH TECH–SCIENCES. SUPERSONIC SMOG OR SONG SMOG COULD DISSRUPT ARCHITECTONICAL CONSTRUCTION OF BUILDING IN THE CITIES ALL OVER THE WORLD. **SUPERSONIC OR SONIC SMOG ALSO KILLS MANY SPECIES OF WHALES!!**

ALL SOUND DIVISIONS OF PHYSICS, FOR EXAMPLE, LIKE AEROSPACE SCIENCE ACOUSTIC OR SOUND TECHNOLOGY, etc. are based on optical laws, like the LAWS OF SNELLIUS (SNELL'S LAW), BRAGG'S LAW, ALSO ARE USING IS SEISMIC OF EARTH AND HELIOSEISMIC.

ACOUSTIC'S IS INCLUDED IN GEOPHYSICS, SEISMIC, OIL AND GAS PROSPECTION ARE SPATIAL SCIENCES APPLY IN GEOSCIENCES AND PHYSICS.

IN MODERN RESEARCH OF THE EARTH BODY IS FOCUSED THE NEWER TECHNOLOGY IN NEUTRINO TOMOGRAPHY OF THE PLANET EARTH.

EARLY WILL BE SIGNIFICANT EXPLORATION OF MOON, MARS AND JUPITER'S GALILEO MOONS: EUROPA, CALLISTO, IO, GANYMED, …

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6. References

[1] J. CELÝ, Quasiparticles in Solid Materials (2004), VUTIUM Brno, 224p. (In Czech)

[2] N.R. HUBER, J. Acoust. Soc. Am. (2017) Mar/141(3), EL239, doi: 10.1121/1.4977099. Optical imaging of propagating Mach Cones in water using refracto-vibrometry – NCBI.
https://www.ncbi.nlm.nih.gov/search/all/?term=doi%2010.1121/1.4977099

[3] [pdf] Observarion of far–field Mach waves generated by the 2001 Kokoxili supershear earthquake Stanford Earth.
https://pangea.stanford.edu/~edunham/publications/Vallee_Dunham_Kokoxili_GRL12.pdf

[4] R. WEINLICH, Nobel Prize for Physics Winners (1998), ALDA, Olomouc, 170p. (In Czech)

[5] https://en.wikipedia.org/wiki/Phonon

[6] [pdf] Mach cone shocks in a two–dimensional Yukawa Solid using a complex plasma, June 2000, doi: 10.1103/PhysRevE.61.5557.
https://www.researchgate.net/publication/235549824_Mach_cone_shocks_in_a_two-dimensional_Yukawa_solid_using_a_complex_plasma

[7] [pdf] Synthesis of a Mach cone using a speaker array. FORUM ACUSTICUM 2014, AT KRAKOW.