

Arbeitsgruppe

Videokonferenztechnologien und ihre Anwendungsszenarien (VIKTAS)



10:15 - 10:45 Uhr aus Berlin

Kugelblitze, gibt's die?

Prof. Dr. Gerd Fußmann

Institut für Physik
Humboldt-Universität zu Berlin

Video-Konferenzen an der HU- Berlin

Gerd Fussmann:

- Lehrstuhl Plasmaphysik an der Humboldt-Universität
- Mitglied der Wissenschaftlichen Leitung (WL) des Max-Planck-Instituts für Plasmaphysik (IPP) mit Standorten in Garching u. Greifswald

WL-Sitzungen (10-12 Mitglieder + Sekretär + Gäste):

1 Sitzung (3 - 5 Std.) pro Woche

+ ca. 5 außerordenliche Sitzungen und 2 Klausuren im Jahr

Seit 2004 etwa **75% der Sitzungen per Video**

Teilnehmer: 5-7 Garching, 3-5 Greifswald, 1 Berlin, (0-1 FZ-Jülich)

Themen:

- Berichte des Wiss. Direktors
- Berichte aus den Abteilungen
- Erörterung wiss.+ techn. Themen (Zeichnungen, Folien)
- Personal-Angelegenheiten
- Verschiedenes

Video-Konferenzen an der HU- Berlin

Kolloquien und Forschungsberichte per Video

mit großen Teilnehmerzahlen in Garching (30), Greifswald (30) und Berlin (5)

Der folgende Vortrag soll ein Beispiel geben für einen Kolloquiumsvortrag über ein aktuelles Forschungsthema der IPP-Arbeitsgruppe Plasmaphysik an der Humboldt-Universität zu Berlin

Kugelblitze, gibt's die ?

Gerd Fußmann

Burkhard Jüttner, Alex Versteegh, Stefan Noack

Outline



- Some historical remarks
- Ball lightning observations in nature
- Recent experiments in Brazil
- Our experiments in Berlin
 - General observations
 - Specific measurements
 - Results and remaining questions
- Conclusions

Historical remarks



Picture of ball lightning in France in 1874



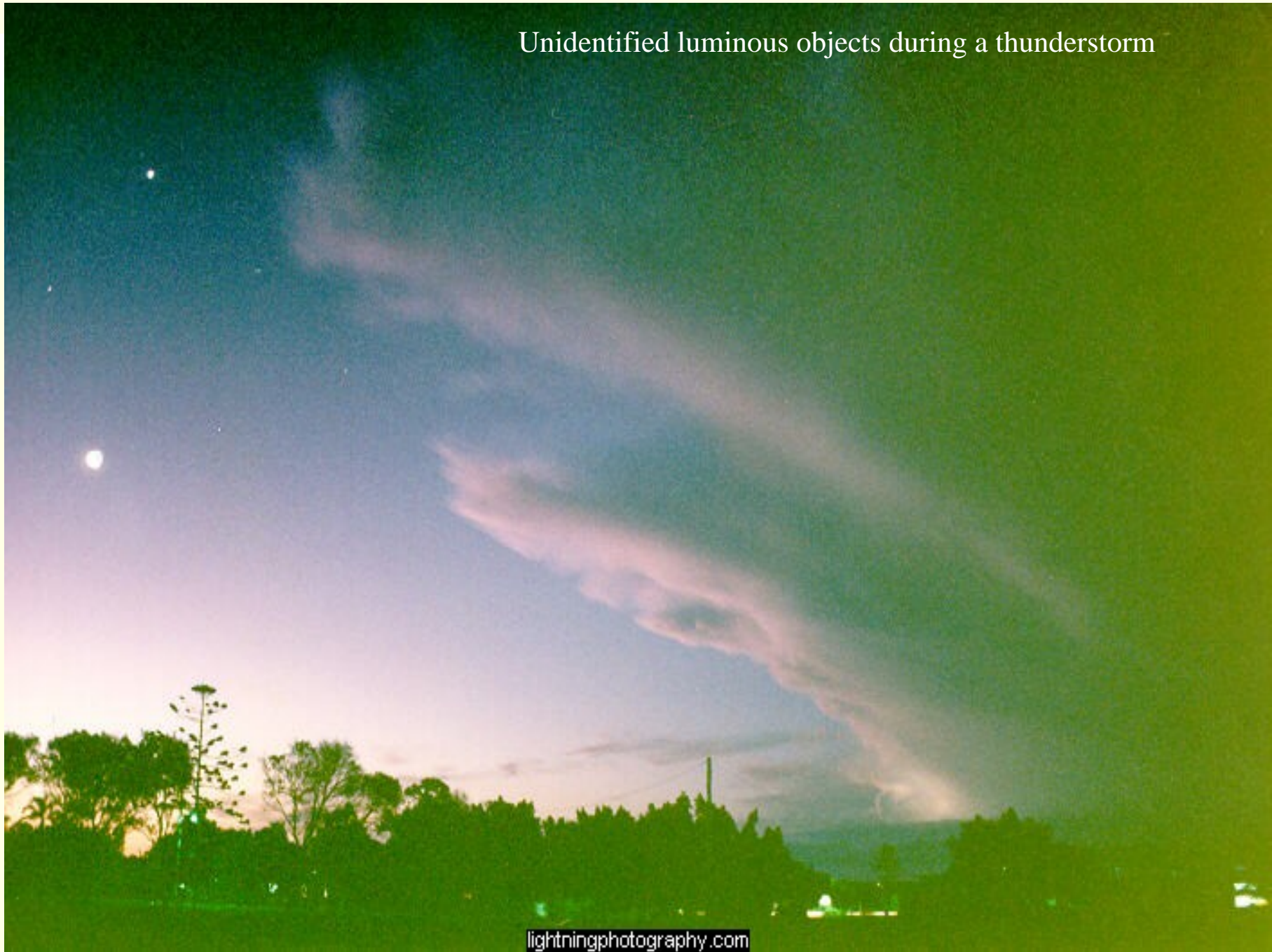
Boule de feu s'introduisant dans une maison dans le quartier de George de Loup à Lyon, 1901

Ball lightning Observations in nature ?

Impressive picture but no ball lightning



Unidentified luminous objects during a thunderstorm



Mysterious events



Lightning stroke into lake Lago Maggiore, Italy

Recent experiments in Brazil

Production of luminous silicon balls

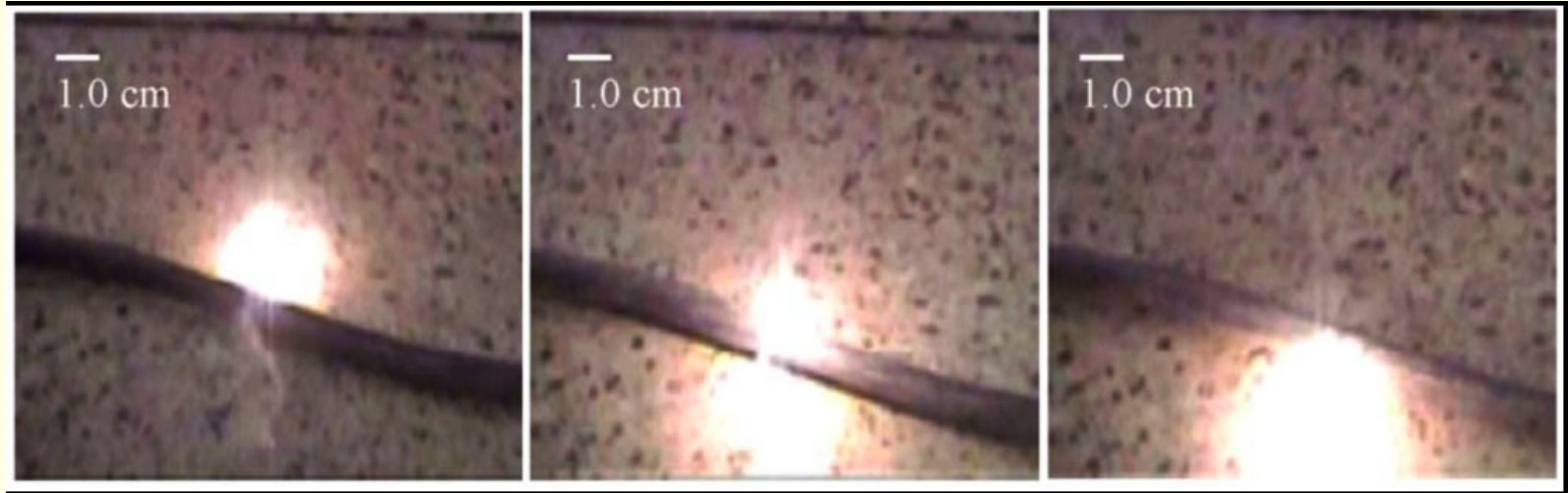


Zur Anzeige wird der QuickTime™
Dekompressor „
benötigt.

Luminous balls of a few cm in diameter lasting up to 8 s have been produced from a silicon wafer by an electric arc (Recife, Brazil).

G.S. Paiva, A.C. Pavao et al., Phys. Rev. Lett. 98, 048501 (2007)

Production of luminous silicon balls



Ball passing through a small gap under a cable

(time interval between frames 80 ms)

Theory by :

John Abrahamson and James Dinn

Nature 403, 519-521 (3 February 2000) | doi:10.1038/35000525;

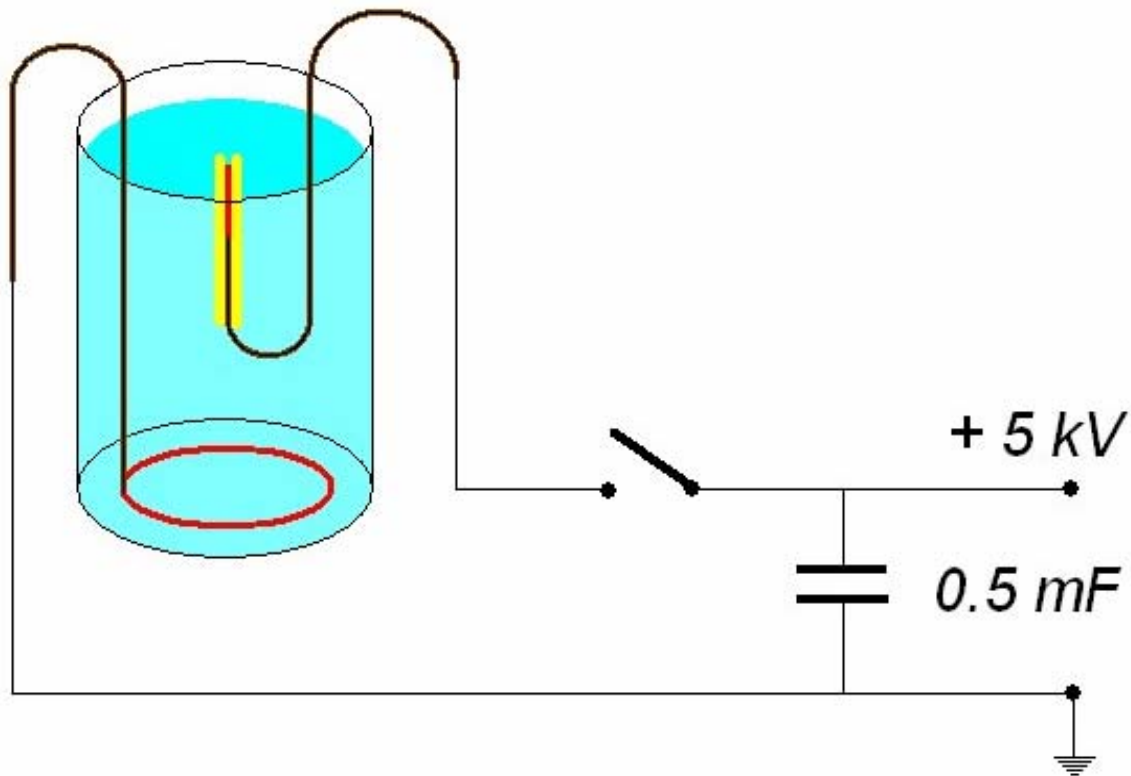
Ball lightning caused by oxidation of nanoparticle networks from normal lightning strikes on soil

Our Experiments

Our experiments are based on those discovered in 2001 by
G. D. Shabanov at
Konstantinov Institute of Nuclear Physics St.Petersburg ¹⁾, ²⁾

- 1) G.D. Shabanov, Proceedings of 3rd International Conference on Natural and Anthropogenic Aerosols, St. Petersburg, 2001, p.368
- 2) A.E. Egorov, S.I. Stepanov, G.D. Shabanov, Physics-Uspekhi 47, 99-101, 2004

Schematic of the Experiment



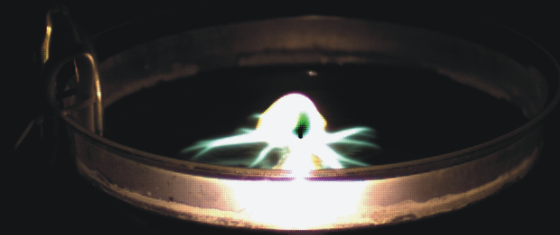
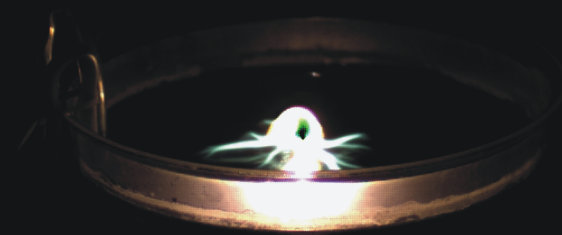
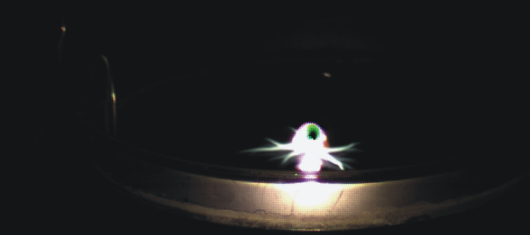
Picture sequence taken with a small digital camera



$t = 2\text{ms}$

$t = 4\text{ms}$

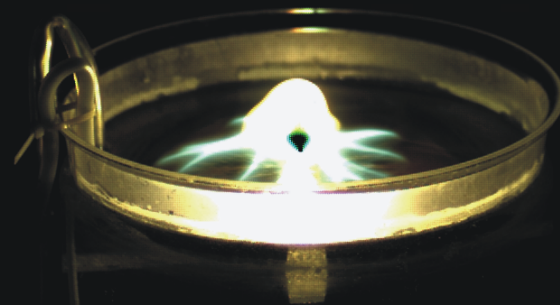
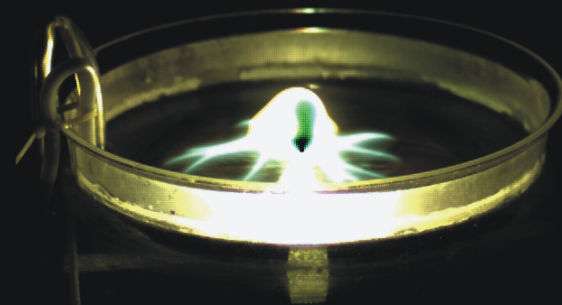
$t = 6\text{ms}$



$t = 8\text{ms}$

$t = 10\text{ms}$

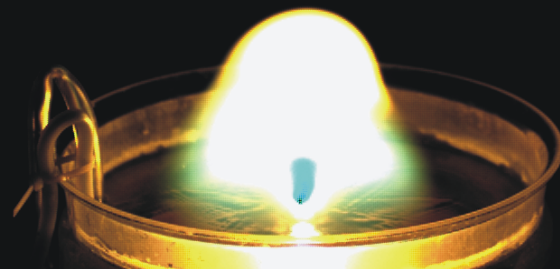
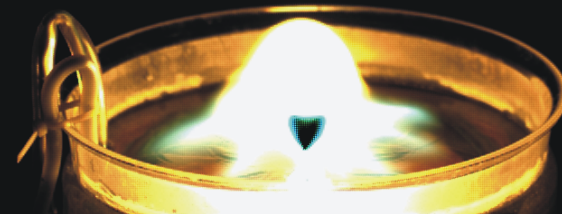
$t = 12\text{ms}$



$t = 22\text{ms}$

$t = 32\text{ms}$

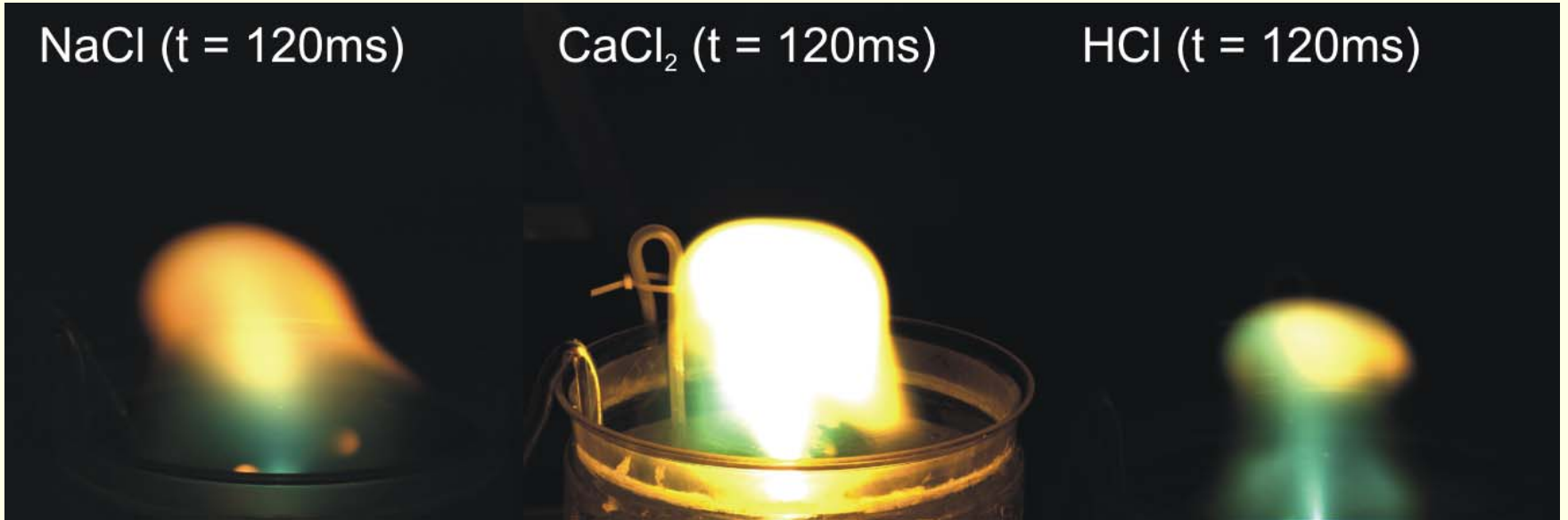
$t = 72\text{ms}$



NaCl (t = 120ms)

CaCl₂ (t = 120ms)

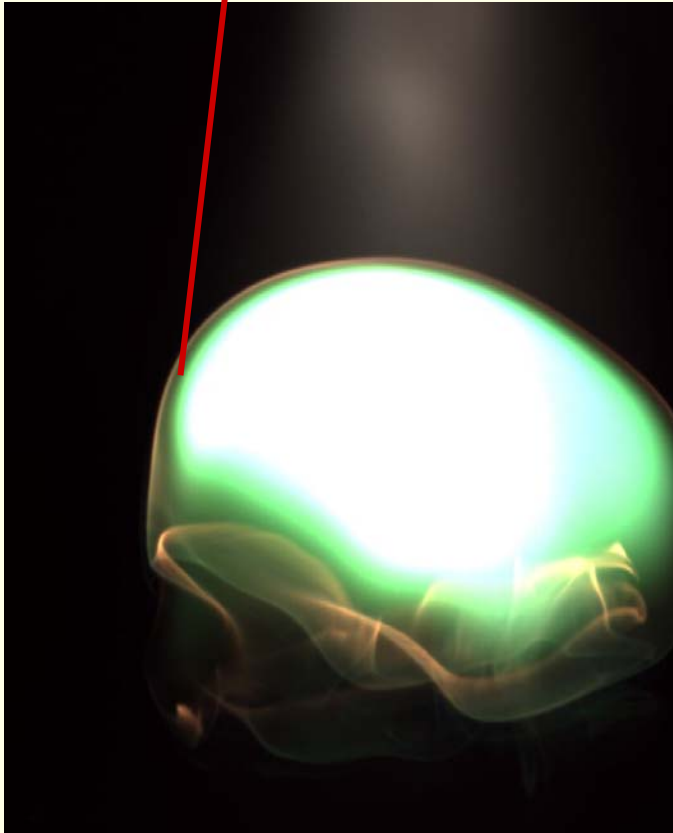
HCl (t = 120ms)



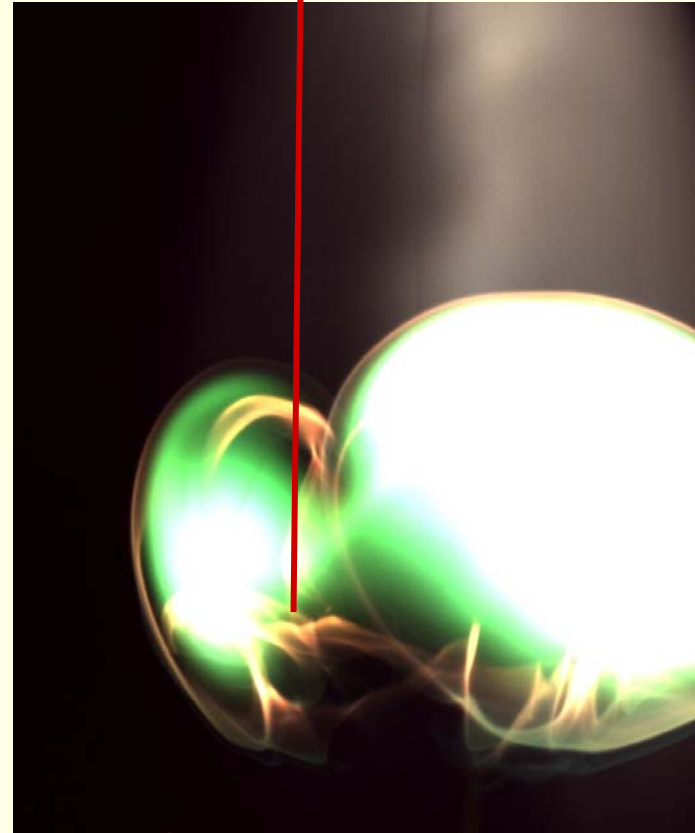
Various salt solutions:

Detailed structures

cold confining skin



turbulent structures

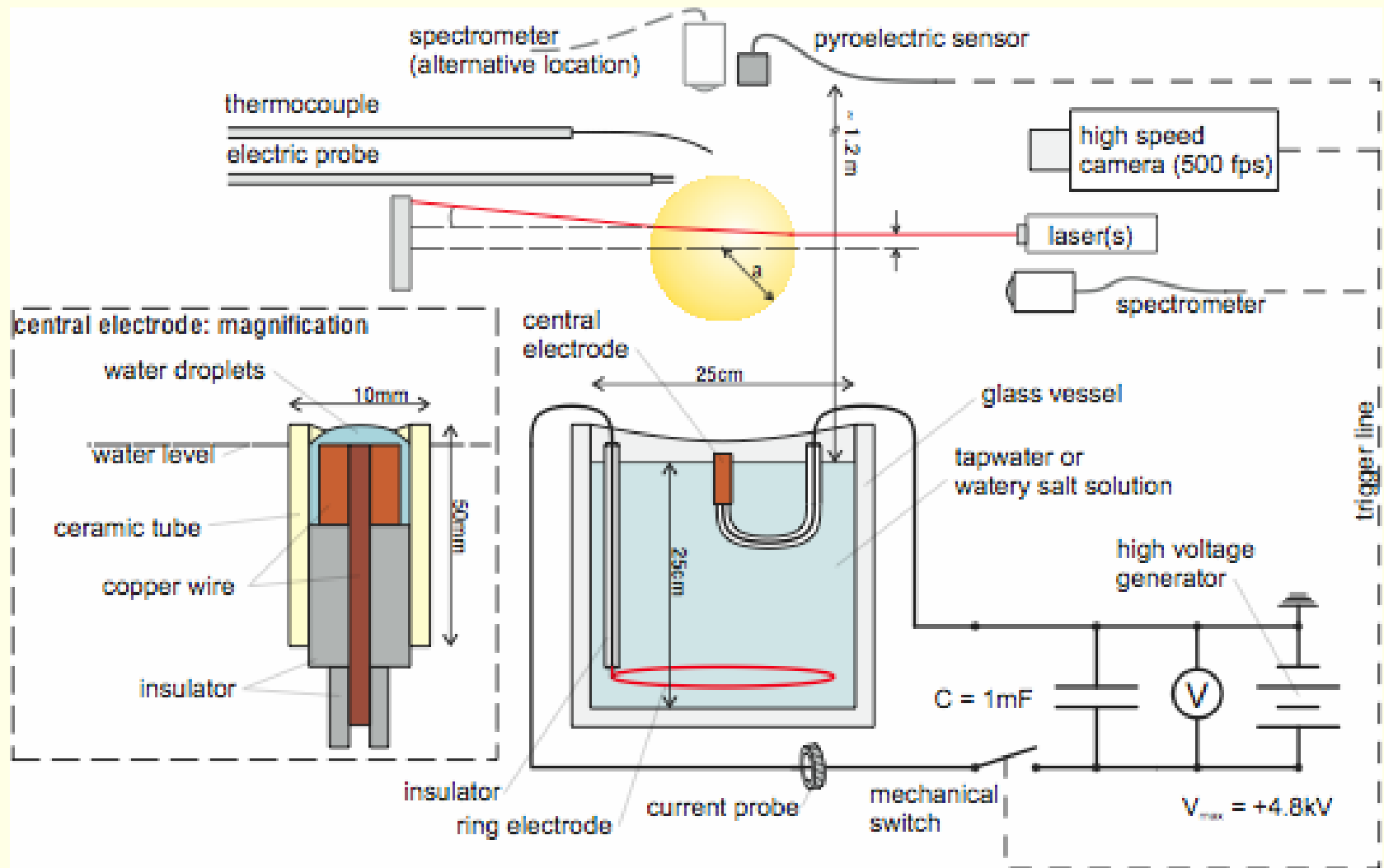


High speed camera films

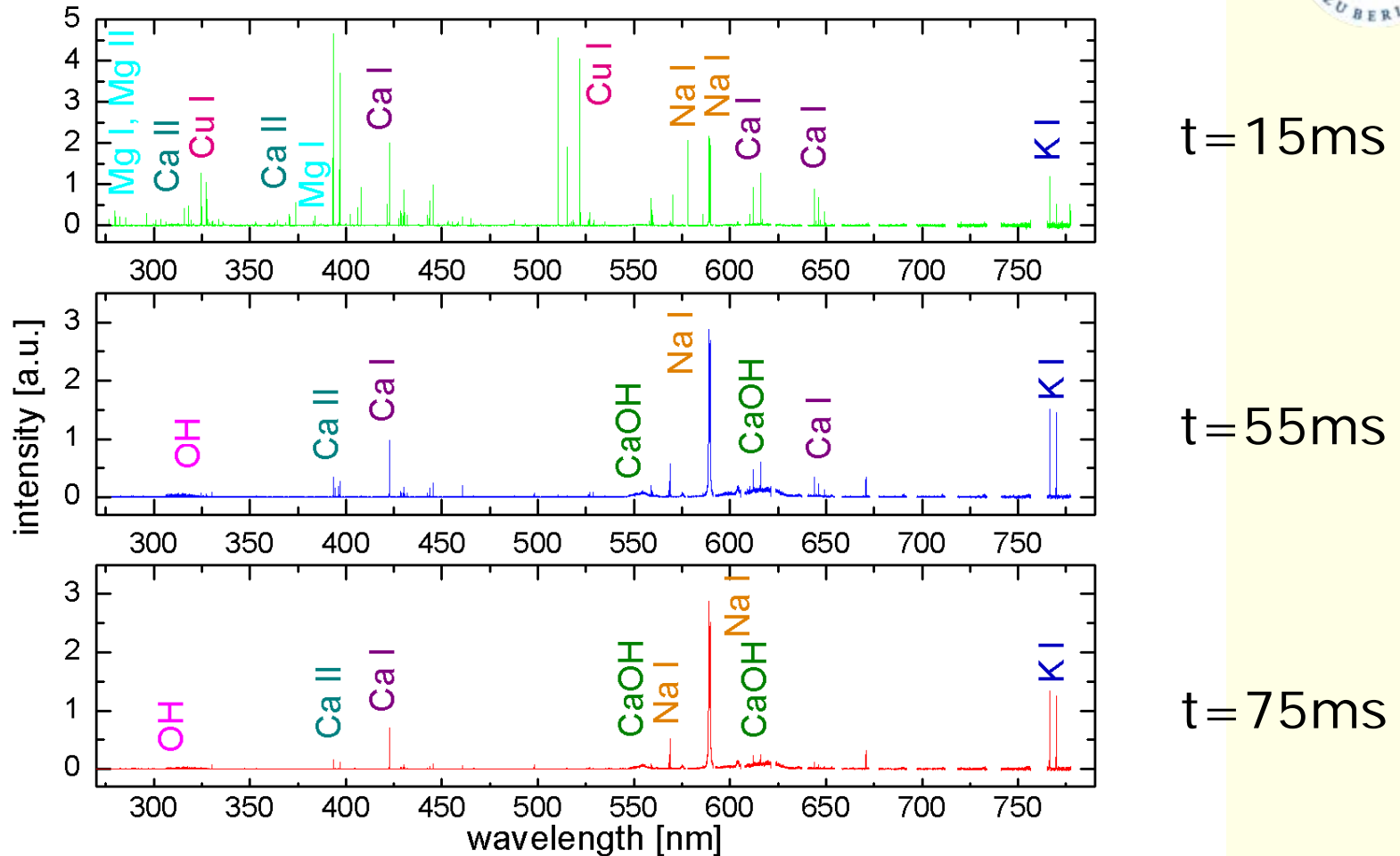
(500 frames per second)

Specific investigations

Experimental setup



Emission spectroscopy (tap water)



Only lines with $E_{\text{exc}} < 5\text{ eV}$ are observed $\Rightarrow T_e < 1\text{ eV}$

Results and remaining questions

Remaining questions



- In what form is the discharge energy stored that allows light emission for several 100 ms?
Initial candidates:
 - o Electrical (no)
 - o Magnetic (no)
 - o Chemical (likely)
- What determines the characteristic shape and confines the plasma?
- What is the rôle of water in the experiments ?
- Can the experiment be improved (prolongated) ?

Kugelblitze, gibt's die ?

Conclusions



In the recent past two different experiments have been performed showing some characteristic features of ball lightning as reported by eye witnesses:

- In case of the **silicon cloud experiments**, balls of about 3 cm in diameter, rolling slowly over ground, are emitting light for many seconds. Apart from being too small (10-30 cm are reported by most observers) and not floating in air they seem to resemble very much ball lightning events in nature.
- **Discharges in water** allow to produce bright clouds of about 20 cm diameter for about 0.3 s by evaporating and ionizing about 0.1 g of water within 0.1 s. Similar clouds are likely to be generated by a lightning stroke that is accidentally conducted into a finite amount of water (~100 g). In these experiments the life time is to be prolonged by a factor of 10 - 30 to comply with the natural phenomenon.

Ball lightning events could not fully reproduced yet in the laboratory experiments, nevertheless appears their occurrence in nature rather likely.

A glowing yellow and green light source, possibly a small flame or a heated object, is contained within a metal vessel. A glass tube is inserted into the vessel, and a thin wire or probe is visible near the light source. The background is dark, making the bright light stand out.

Thank you!