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Observations by the LOFAR radio telescope of a fast negative leader propagation mode

The LOFAR Lightning and Cosmic ray group

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LOFAR observation of a Intensely Radiating Negative-Leader mode

Olaf Scholten, University of Groningen, for the LOFAR-Lightning group

IRNL structure seen at initial stage for all flashes.

IRNL properties

- Strongly radiating (VHF & broadband)
- High speed (10^6 m/s)
- Virgin air
- Spawns many negative leaders

Here: one example of multiple times during a flash

Twice at the same spot!

Probably caused by a local dense charge cloud (since twice at same spot)

Always seen at initiation → lightning initiates only in regions with enhanced E fields.

Overview of flash B

Initial part of Flash B

First 50 ms of flash A

Recent publications of the LOFAR lightning group

A Distinct Negative Leader Propagation Mode

Scholten O, Hare BM, Dwyer J, Liu N, Sterpka C, Kolmašová I, Santolík O, Lán R, Uhlíř L, Buitink S, Corstanje A, Falcke H, Huege T, Hörandel JR, Krampah GK, Mitra P, Mulrey K, Nelles A, Pandya H, Rachen J ... [Show all 24] ... Winchen T

Preprint from Research Square, 14 Apr 2021
DOI: 10.21203/rs.3.rs-402945/v1 PPR: PPR312058

Preprint

Distinct Negative leader

⚠ This article is a preprint. It may not have been peer reviewed. ⓘ

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Research Article | Open Access |

The Initial Stage of Cloud Lightning Imaged in High-Resolution

O. Scholten✉, B. M. Hare, J. Dwyer, C. Sterpka, I. Kolmašová, O. Santolík, R. Lán, L. Uhlíř, S. Buitink, A. Corstanje, H. Falcke, T. Huege, J. R. Hörandel, G. K. Krampah, P. Mitra, K. Mulrey ... See all authors ▾

First published: 28 January 2021 | <https://doi.org/10.1029/2020JD033126>

JGR Atmospheres Electric Fields

Research Article | Open Access |

Determining Electric Fields in Thunderclouds With the Radiotelescope LOFAR

T. N. G. Trinh, O. Scholten✉, S. Buitink, U. Ebert, B. M. Hare, P. R. Krehbiel, H. Leijnse, A. Bonardi, A. Corstanje, H. Falcke, T. Huege, J. R. Hörandel, G. K. Krampah, P. Mitra, K. Mulrey ... See all authors ▾

First published: 04 April 2020 | <https://doi.org/10.1029/2019JD031433> | Citations: 1

JGR Atmospheres Needle Propagation

Research Article | Open Access |

Needle Propagation and Twinkling Characteristics

B. M. Hare✉, O. Scholten, J. Dwyer, C. Sterpka, S. Buitink, A. Corstanje, H. Falcke, J. R. Hörandel, T. Huege, G. K. Krampah, P. Mitra, K. Mulrey, A. Nelles, H. Pandya, J. P. Rachen ... See all authors ▾

First published: 24 February 2021 | <https://doi.org/10.1029/2020JD034252>

Radio Emission Reveals Inner Meter-Scale Structure of Negative Lightning Leader Steps

B. M. Hare, O. Scholten, J. Dwyer, U. Ebert, S. Nijdam, A. Bonardi, S. Buitink, A. Corstanje, H. Falcke, T. Huege, J. R. Hörandel, G. K. Krampah, P. Mitra, K. Mulrey, B. Neijzen, A. Nelles, H. Pandya, J. P. Rachen, L. Rossetto, T. N. G. Trinh, S. ter Veen, and T. Winchen

Phys. Rev. Lett. **124**, 105101 – Published 10 March 2020

Negative leader Stepping

Letter | Published: 17 April 2019

Needle-like structures discovered on positively charged lightning branches

B. M. Hare✉, O. Scholten✉, [...] P. Zucca

Nature **568**, 360–363(2019) | [Cite this article](#)

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Needles

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Timing Calibration and Windowing Technique Comparison for Lightning Mapping Arrays

Timing Calibration

Authors

Brian Hare , Harald E. Edens , Paul R. Krehbiel, William Rison, O. Scholten , S. Buitink , A. Corstanje, H. Falcke, J.R. Horandel, Tim Huege, G. K Krampah, P. Mitra, K. Mulrey , Anna Nelles, Hershaf Pandya , Jörg P. Rachen, S. thoudam, T. N Trinh , S. Veen, Tobias Winchen

Most recent preprint (this week):

Time resolved 3Dinterferometric imaging of a section of a negative leader with LOFAR

[Olaf Scholten](#), [Brian Hare](#), [Joe Dwyer](#), [Ningyu Liu](#), [Chris Sterpka](#), [Stijn Buitink](#), [Tim Huege](#), [Anna Nelles](#), [Sander ter Veen](#)

We have developed a three dimensional (3D) interferometric beamforming technique for imaging lightning flashes using Very-High Frequency (VHF) radio data recorded from several hundreds antennas with baselines up to 100~km as offered by the Low Frequency Array (LOFAR). The long baselines allow us to distinguish fine structures on the scale of meters while the large number of antennas allow us to observe processes that radiate at the same intensity as the background when using a time resolution that is close to the impulse-response time of the system, 100~ns. The new beamforming imaging technique is complementary to our existing impulsive imaging technique. We apply this new tool to the imaging of a four stepped negative leaders in two flashes. For one flash, we observe the dynamics of coronal flashes that are emitted in the stepping process. Additionally, we show that the intensity emitted in VHF during the stepping process follows a power-law over 4 orders of magnitude in intensity for four leaders in two different lightning storms.

Reference:

[arXiv:2104.11908](#)