

Active actinometry on a cold hydrogen afterglow

Citation for published version (APA):

Graaf, de, M. J., Qing, Z., Severens, R. J., Otorbaev, D. K., Sanden, van de, M. C. M., & Schram, D. C. (1993). Active actinometry on a cold hydrogen afterglow. In *1993 IEEE International Conference on Plasma Science : 7-9 June 1993, conference record - abstracts / Ed. A. Ng* (pp. 140). Institute of Electrical and Electronics Engineers.

Document status and date:

Published: 01/01/1993

Document Version:

Publisher's PDF, also known as Version of Record (includes final page, issue and volume numbers)

Please check the document version of this publication:

- A submitted manuscript is the version of the article upon submission and before peer-review. There can be important differences between the submitted version and the official published version of record. People interested in the research are advised to contact the author for the final version of the publication, or visit the DOI to the publisher's website.
- The final author version and the galley proof are versions of the publication after peer review.
- The final published version features the final layout of the paper including the volume, issue and page numbers.

[Link to publication](#)

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain
- You may freely distribute the URL identifying the publication in the public portal.

If the publication is distributed under the terms of Article 25fa of the Dutch Copyright Act, indicated by the "Taverne" license above, please follow below link for the End User Agreement:

www.tue.nl/taverne

Take down policy

If you believe that this document breaches copyright please contact us at:

openaccess@tue.nl

providing details and we will investigate your claim.

Tuesday, 8 June 1993

9:45 am – Room 207

ORAL SESSION 3B

Plasma Diagnostics

Chair: N. Hershkowitz

3B1

Diagnostics of Magnetic Antenna Fields for Low Frequency Whistlers in r - t and ω - k Space*

C.L. Rousculp, J.M. Urrutia and R.L. Stenzel
Dept. of Physics, University of California
Los Angeles, CA 90024-1547, USA

In a large uniform laboratory plasma ($n_e = 3 \times 10^{11} \text{ cm}^{-3}$, $kT_e = 2 \text{ eV}$, $B_0 = 15 \text{ G}$, $Ar \ 2 \times 10^{-4} \text{ Torr}$, 1m diam. \times 2.5m length) the magnetic field $B_{(r,t)}$ of a shielded magnetic loop antenna (5 cm diam.) has been measured in both near and far zones.¹ The antenna is driven with a single short current pulse ($t_p = 0.2 \mu\text{s}$) which excites a whistler wave packet ($\omega \ll \omega_{ce}$). With a movable magnetic probe and repeated pulses the three-dimensional vector field B_x, B_y, B_z vs. x, y, z is mapped at 10,000 spatial positions with high time resolution ($\Delta t = 10 \text{ ns}$). In the space-time domain the evolution of a dispersive wave packet from the antenna near-zone ($r < \lambda$) fields is observed. The wave packet consists of nested cones propagating with wave normals highly oblique to B_0 but energy flow at a small angle to B_0 . In order to analyze the wave packet in terms of eigenmodes, the field $B_{(r,t)}$ has been Fourier transformed in time and three-dimensional space, $B_{(\omega,k)}$. At a selected frequency, ω , the finite-size antenna launches a spectrum of k -vectors which, for an antenna dipole moment along B_0 , is highly axisymmetric ($k_{\perp}(\phi) = \text{const.}$). In the $k_{\perp} - k_{\parallel}$ plane the wave energy is spread out along the refractive index curve of whistlers with the largest wave energy oblique to B_0 . At different frequencies the energy distribution in k -space follows the theoretical refractive index surfaces. By selecting a single ω and k the properties of plane, oblique whistlers, which are difficult to excite directly, can be investigated. For example, the polarization of B along k is readily found from an inverse FFT. Hence, the digital analysis of wave packets is a useful diagnostic technique to study wave properties.

1. R.L. Stenzel, J.M. Urrutia and C.L. Rousculp, Phys. Fluids (Feb. 1993).

*Supported in part by NSF PHY, ATM and NASA grants.

3B2

Active actinometry on a cold hydrogen afterglow

M.J. de Graaf, Z. Qing, R. Severens, D.K. Otorbaev[†], M.C.M. van de Sanden and D.C. Schram,

Department of Physics, University of Technology,
P.O.Box 513, 5600 MB, Eindhoven, The Netherlands

[†] Scientific Engineering Center Jalyn,
Kirghizstan Academy of Sciences,

Chu Prospect 265A, Bishkek, 720071, Kirghizstan

A new method of actinometry is developed to characterize the cold afterglow of an expanding thermal plasma source in hydrogen. A small electrode is placed in the afterglow to generate a local low frequency (100-500 kHz) plasma. In this plasma fast

electrons are created that can excite particles from the ground state to visible light emitting levels. The atomic Balmer α line and the molecular Fulcher band are used to determine the atomic and molecular abundances of the plasma. Furthermore, rotational and vibrational populations of molecular hydrogen are studied.

The power input from the low frequency discharge is kept low enough to assure that the plasma composition and the gas temperature are not significantly influenced. Active actinometry thus offers a method to sample the composition and the ground state molecular populations of the flowing afterglow plasma. The method has successfully been applied under plasma conditions with a low electron temperature ($< 0.2 \text{ eV}$) and a low electron density ($< 10^{17} \text{ m}^{-3}$).

3B3

Resonant Holographic Interferometry Measurements of Laser Ablated Atom Absolute-Line-Density Profiles In Vacuum, Gases, and Plasmas.†

R.A. Lindley*, R.M. Gilgenbach,
C.H. Ching, J.S. Lash, and Y.Y. Lau
Intense Energy Beam Interaction Laboratory
Nuclear Engineering Department
University of Michigan
Ann Arbor, MI 48109-2104

Two-dimensional, species-resolved, double pulsed, holographic interferometry has been used to investigate the hydrodynamics of KrF laser ablation plumes in vacuum, gases, and RF/plasmas. To produce the laser ablation plume, a KrF excimer laser (40 ns, 248 nm, $\leq 0.8 \text{ J}$) was focused onto a solid aluminum target at a fluence of 1.9 - 4.7 J/cm². The interferograms were made using a XeCl excimer laser pumped dye laser (20 ns, $\approx 5 \text{ mJ}$) tuned at or near ($\pm 0.100 \text{ nm}$) the 394.401 nm aluminum neutral transition from ground state. Calculations have been performed to obtain aluminum-neutral absolute-line-density profiles from the resonant fringe shift data, assuming an average kinetic plume temperature of $\approx 0.3 \text{ eV}$ and a dye laser bandwidth of $\approx 0.0031 \text{ nm}$. Peak aluminum neutral line-densities of up to $9 \times 10^{14} \text{ cm}^{-2}$ have been measured for plumes in backgrounds of 1 Torr and 35 Torr argon, 1 Torr argon RF-plasma, and in vacuum.

[†]Research Supported By NSF Grant CTS-9108971

*Supported By A DOE Magnetic Fusion Fellowship