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CENTRE D'ETUDES NUCLEAIRES DE SACLAY

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ABSORPTION OF ALUMINUM X-RAY LINES IN A LASER CREATED GOLD PLASMA

P. COMBIS, M. BUSQUET, M. LOUIS-JACQUET.

COMMISSARIAT A L'ENERGIE ATOMIQUE
CENTRE D'ETUDES DE LIMEIL-VALENTON
B. P. N° 27
94190 VILLENEUVE-SAINT-GEORGES

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We have studied the absorption of aluminum X-ray lines through a gold plasma by focusing a high intensity laser-beam onto a specific target. Absorption in the wavelength range of 5 to 7 Å has been evidenced and measured for Aluminum resonance lines.

La focalisation d'un faisceau laser intense sur une cible adaptée nous a permis de mettre en évidence et de mesurer l'absorption des raies de résonance de l'aluminium par un plasma d'or dans la gamme de longueur d'onde 5-7 Å.

The metal dots were made thick enough ($> 1 \mu\text{m}$) to prevent the ablation of the substrate material. The set of the disc and the square dots was fully covered by the laser focal spot whose diameter was chosen to be of $600 \mu\text{m}$ providing a mean irradiance of $3 \cdot 10^{13} \text{ W. cm}^{-2}$. The aluminum square dot acted as a X-ray source and the absorption of its radiation could be observed through the gold disc in the longer direction.

Absorption of the source radiation was analyzed by means of two identical spectrographs viewing in the two main directions of the square-disc set, transverse (T) and longitudinal (L), (Fig.2).

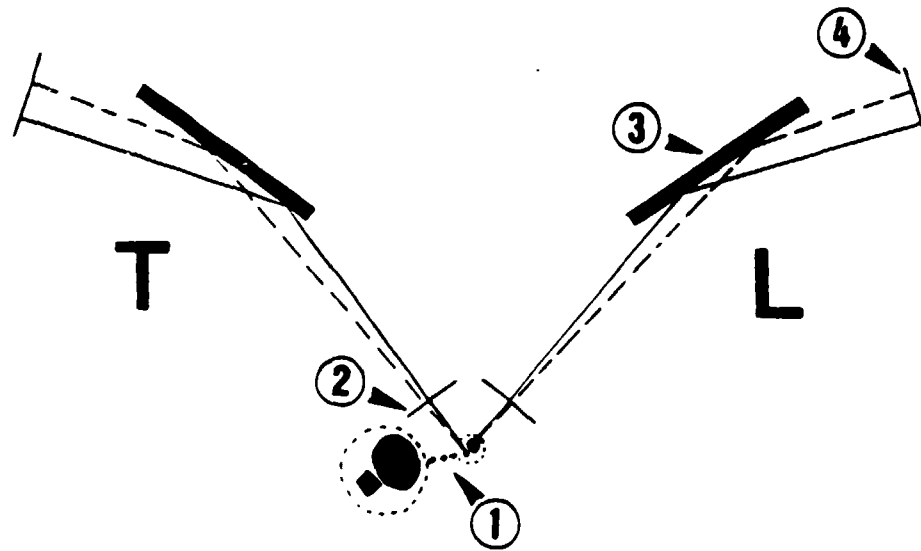


Figure 2 : Experimental Set-up.

1 - Front view of the target.
2 - Spatial resolution slit.

3 - Flat TAP crystal.
4 - SB2 Kodak Film.

Spectral dispersion was achieved through the use of flat TAP crystals, and each spectrograph was equipped with a $10 \mu\text{m}$ -width slit providing the spatial resolution along the direction of the plasma expansion.

Figure 3 shows the spatial variation of the H-like and He-like resonance lines intensities (integrated over the whole line profile) of aluminum versus the distance from the initial target position for the two directions of observation (L) and (T). Strong absorption by the gold plasma is clearly seen for these the lines even far in the plume, though gold emission is not important enough to be detectable at distances from the target surface larger than $50 \mu\text{m}$, at least in the observed wavelength range.

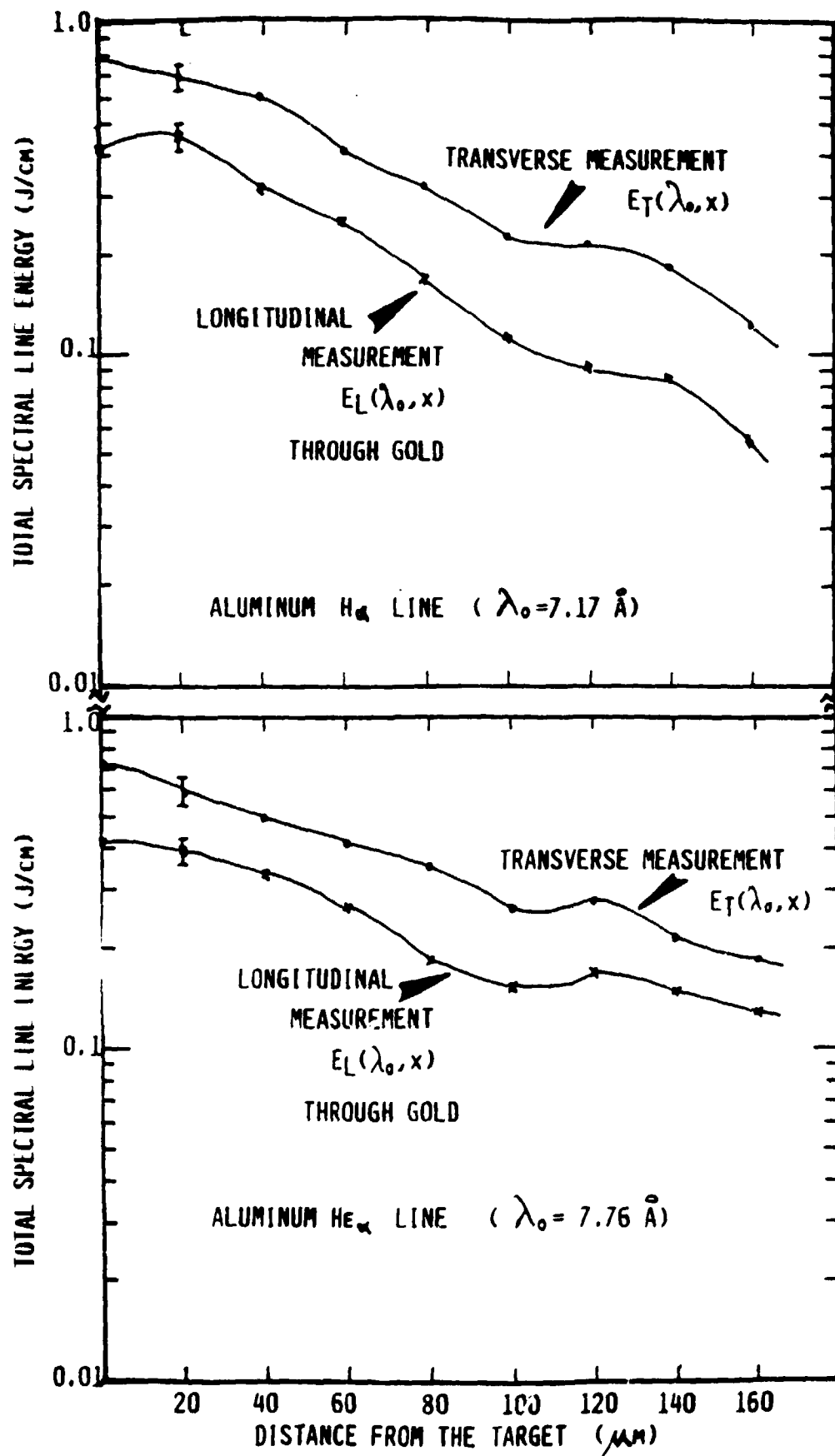


Figure 3 : Line integrated energy of aluminum lines versus the distance from the target.

Interpretation of the results is done through few simple assumptions. Slabs of gold plasma located at a given distance from the target surface are supposed to have homogeneous density and temperature. Temporal variations of the absorption coefficient are considered to be very small as the time duration of aluminum emission is shorter than the evolution time of the gradients (this has been checked in previous experiments with both temporal and spatial resolution [3]). Then the ratio of the total energy for a given line (at wavelength λ) emitted at a distance X , by the source and absorbed by the gold plasma and measured in the L and T directions is :

$$\frac{E_L(\lambda, X)}{E_T(\lambda, X)} = \exp(-K_\lambda(X) \cdot L)$$

where $K_\lambda(X)$ is the gold spectral absorption coefficient at the distance X , of an aluminum line of wavelength λ ; L is the longitudinal dimension of the gold plasma, which is supposed to have no variation with X , as a result of the confinement by the surrounding silica plasma.

The inferred K_λ values for the He_α ($1s^2 - 1s2p$, $\lambda = 7.76 \text{ \AA}$) and H_α ($1s - 2p$, $\lambda = 7.17 \text{ \AA}$) aluminum lines are reported in Fig.4.

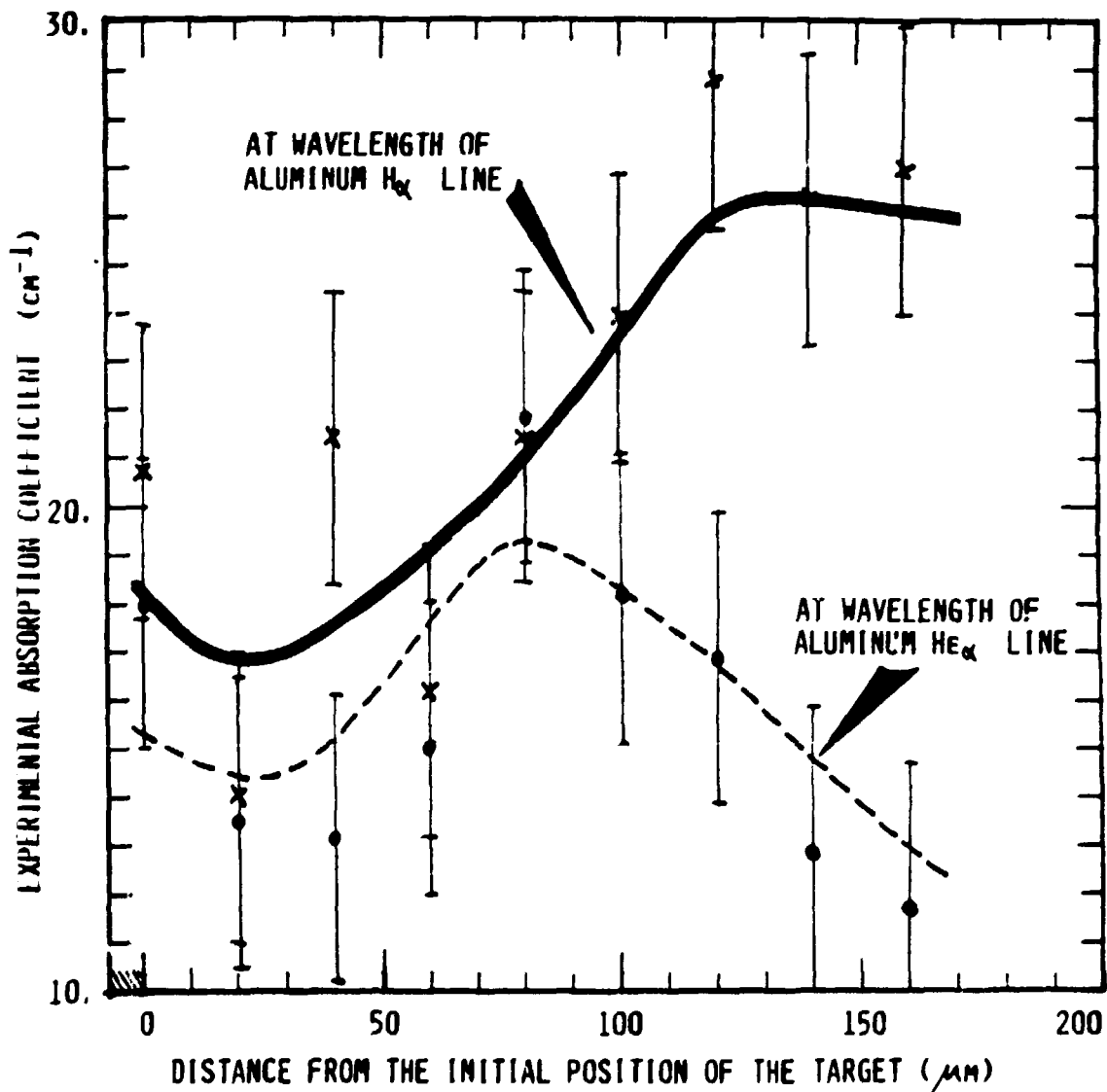


Figure 4 : Absorption coefficient of Aluminum H-like and He-like lines in a gold plasma deduced from experimental measurements.

In conclusion, we have shown that, with a specific target geometry, the X-ray spectral absorption can be evidenced and measured in a high-Z laser created plasma by means of a close X-ray source created in the same laser shot.

REFERENCES

- [1] Louis-jacquet M., Combis P. (1983) C.R. Acad. Sci. 296, 1019
- [2] Combis M., Louis-jacquet M. (1984) Phys. Rev. A 29, 1606
- [3] Combis M., Louis-jacquet M. (1984) C.R. Acad. Sci. 299, 275