# Observation quasi-periodic structures of laser-air plasma [‡]

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**Synopsis** We observe the quasi-periodic longitudinal structures of plasma generated by the nanosecond laser breakdown in air. Experimental results indicate that the long foci lens utilized to focus main laser beam can cause periodic structures of plasma.

The laser-gas plasma channel has been of much interest because of many important applications, such as stimulated Raman backscattering [1-4], plasma waveguide [5-7], high harmonic generation [8, 9], plasma accelerator [10, 11], and etc. However, in most cases of laser breakdown in gas the plasma channel has a quasi-periodic longitudinal structure which may limit its potential applications. This experimental work provides quasi-periodic structures of plasma generated by the nanosecond laser breakdown in air through varying three variables of laser energy, plasma evolution, and foci of lens.

In experimental setup, the plasma channels are detected by optical interferometry technique. A short wavelength beam is separated into reference beam and probing one. The probing beam passes through the plasma channel, generated by an intense main laser beam breakdown in air, and is combined with the reference beam to form linear interference fringes. An optical imaging system is utilized to zoom in the interference fringes. And the interference fringes are imaged on charge-coupled-device camera.

The plasma channels, generated through varying laser energy, plasma evolution, and foci of lens, are presented in Fig.1. When short foci lens is utilized to focus main laser beam, under the different laser energies and different plasma evolutions the quasi-periodic structure is absent from plasma channels (Fig.1, two upper fragments). But when a long foci lens is utilized, some clear quasi-periodic structures appear in plasma channels (Fig.1, lower fragment, the periodic structures are marked by the red arrows in). The longer the lens foci is, the more serious periodic structures plasma channels have.

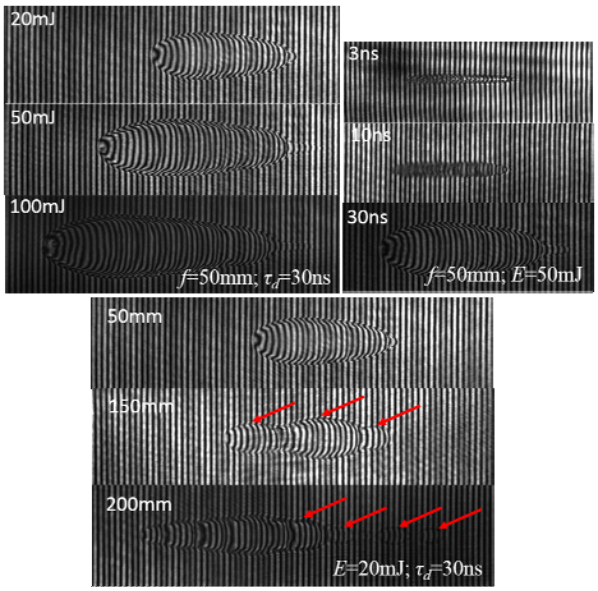


**Figure 1.** Interferograms of plasma channels: Absence of periodic structures under lens foci $f$ =50mm, different laser energies $E$=20mJ, 50mJ, 100mJ (upper left) and different expansion times $\tau_d$ =3ns, 10ns, 30ns (upper right); Appearance of periodic structures under different lens foci $f$ =50mm, 150mm, 200mm, laser energy $E$ =20mJ and expansion time $\tau_d$ =30ns (lower). The red arrows are marks of periodic structures.

## References

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[‡] Project supported by the National Natural Science Foundation of China (No. 11465016 )