利用雙色光短脈衝雷射產生之電漿態激發寬頻兆赫波

Broadband Terahertz Emission by two-color Laser-Induced filament in isotropic media

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摘要

利用聚焦短脈衝雷射產生之空氣電漿所輻射出的寬頻兆赫波，其理論可以用瞬時光電流模組來解釋，空氣分子經由聚焦的雙色短脈衝雷射離子化產生電漿，自由電子受到雙色雷射脈衝的驅動產生具有方向性的瞬時光電流，而這個瞬時光電流被視為是寬頻兆赫波的發射源。其中，雙色雷射脈衝之間的相位差是一個影響兆赫波強度的重要因素，模擬結果顯示，相位差為 $\pi/2$ 時產生之兆赫波強度比起相位差為 0 時強很多，因為較為不對稱的電場分佈會得到較強的方向性電流。其他影響兆赫波強度的因素也會在論文中被討論，例如入射雷射強度、二倍頻轉換效率、波長和脈衝寬度等。此外，瞬時光電流模組也用來討論不同階的混頻光對於兆赫波產生的可能性。

此外，利用固態材料可以產生比氣體更高密度的電漿的特點，實驗上我們亦利用雙色短脈衝雷射打入石英玻璃，量測經由石英玻璃內部電漿產生的兆赫波，並與用空氣電漿產生的兆赫波訊號做比較。

Abstract

Laser-induced gas-plasma or filament can be used as the emitter of intense, coherent and broadband terahertz (THz) wave. The generation process can be well-described by transient photocurrent model, in which the transient current caused by two-color laser field is the source of broadband THz radiation. The air molecules are ionized by focused two-color laser field, and free electrons driven by the laser field will form the directional transient current radiating the THz wave. The relative phase between two-color laser field is an important factor that will affect the output

THz yield. Simulation of THz emission by the transient photocurrent model is carried out in this work. Because of the stronger directional transient current under the influence of asymmetric electric field, the THz yield will be much stronger when the relative phase equals to $\pi/2$ than 0. The dependences of other parameters on generating THz radiation are also discussed. These include pumping intensity, power conversion efficiency, wavelength, and pulse duration. The dependence of pumping intensity on THz emission has been compared to the experimental results. Furthermore, by multi-color laser field are also investigated..

On the other hand, the plasma density is much higher in solid-state materials than that in the gas. Therefore, we also conducted studies of THz generation from solid-state material, fused silica.