limitation of electromagnetic undulators. The normalized transverse momentum, p_β, imparted to a free-electron bunch by a laser-based undulator is constrained to be directly proportional to the normalized vector potential of the undulator, a_u. This severely limits the strength of the resulting oscillatory motion. But in the experiments conducted by Cipiccia *et al.*, the electrons are not free but focused by the ion channel of the LWFA, which relaxes the above constraint. Consequently, when the bounce frequency of the bunch in the channel (or its odd harmonic) is matched to the Doppler-shifted frequency of the laser undulator, a considerable amount of resonant energy transfer from the laser to both transverse (betatron) and longitudinal degrees of freedom of the bunch can occur. Previous theoretical and experimental work[3,4] concentrated on the latter effect, also known as the direct laser acceleration (DLA), but no direct evidence for transverse energy transfer had been found. In their experiments[2], Cipiccia *et al.* found that resonant energy transfer could indeed drive strong betatron motion and excite much higher harmonic orders than is possible under the constraint of free electrons.

Indeed, under the right experimental conditions, the spectrum of these harmonics can extend into the MeV range, which the researchers observed[2]. In fact, this observation of high harmonic generation could provide the first (albeit somewhat indirect) experimental evidence of DLA, which has so far been elusive. Particle-in-cell (PIC) numerical simulations (Fig. 1b) confirm the spatial overlap between accelerated short electron bunch (of order 10 fs in duration) and the laser beam. Limited self-injection into a rapidly expanding plasma bubble[9] is responsible for the ultra-short duration of the bunch, and, therefore, of the gamma-ray pulse. As a historical note, the combination of resonantly tuned undulator and external transverse focusing has been successfully used in the past for designing large-orbit microwave free-electron lasers[10].

Although the energy of the gamma-rays Cipiccia *et al.* produce is modest, the path to generating high energies seems straightforward. Using larger laser powers and more tenuous plasmas should result in multi-MeV gamma-ray bursts sufficient for initiating photonuclear reactions in the giant dipole resonance (GDR) regime. Synchronizing those ultra-short bursts with laser probes would result in the first real-time 'movies' of photo-induced nucleosynthesis. For more modest (keV-scale) energies of gamma-rays, there is an even more immediate possibility of a developing a fully-coherent laser-driven gamma-ray laser on a table top. ❐

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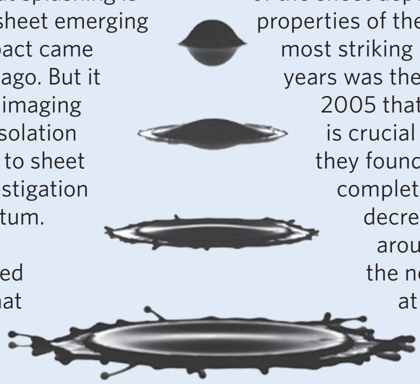
FLUID DYNAMICS

The air down there

Often the most familiar phenomena evade a clear physical description. That a liquid droplet makes a splash when it hits a smooth dry surface would strike most people as fairly intuitive. In fact, its ubiquity belies an intriguing complexity that we are still struggling to understand. Michelle Driscoll and Sidney Nagel have now written the latest chapter in the story (*Phys. Rev. Lett.* **107,** 154502; 2011).

The realization that splashing is linked to a thin fluid sheet emerging from the point of impact came nearly half a century ago. But it wasn't until ultrafast imaging techniques enabled isolation of the events leading to sheet ejection that the investigation really gained momentum. Temporally resolved observations prompted theoretical studies that pointed towards the existence of an air layer between drop and surface that might cushion the impact, inducing the ejection of the thin liquid sheet. Driscoll and Nagel argue otherwise, with the results of a high-speed interference imaging study that provides strong evidence to suggest that no such layer persists as the droplet spreads.



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This is not to say that the pair downplay the importance of the liquid–gas interface — quite the contrary. Although it came as no surprise to learn that formation of the sheet depends on the physical properties of the fluid and substrate, the most striking development in recent years was their group's finding in 2005 that the surrounding gas is crucial for splashing. In fact, they found that splashing can be completely suppressed by decreasing the air pressure around the droplet, supporting the notion that air dynamics at the liquid–gas interface fulfils a splash-stabilizing role.

The threshold pressure at which this occurs depends on the viscosity of the liquid, which also seems to affect the mechanism: splashing of high-viscosity liquids is significantly delayed, compared with their less-viscous counterparts. This time separation between impact and splash ultimately enabled Driscoll and Nagel's investigation of air-layer formation. Using a syringe pump to produce water and glycerol droplets, they measured the thickness of the air layer using interferometric high-speed imaging, and saw that an initial air bubble created on impact quickly vanished, leaving no trace of an air layer by the time the sheet was ejected.

The finding suggests that splashing originates at the edge of the droplet, and puts us one step closer to controlling a mechanism with widespread implications for applications, from automotive to agricultural.

ABIGAIL KLOPPER