The dynamics of laser droplet generation

Blaz Krese, Matjaz Perc, Edvard Govekar

(Submitted on 1 Mar 2010)

We propose an experimental setup allowing for the characterization of laser droplet generation in terms of the underlying dynamics, primarily showing that the latter is deterministically chaotic by means of nonlinear time series analysis methods. In particular, we use a laser pulse to melt the end of a properly fed vertically placed metal wire. Due to the interplay of surface tension, gravity force and light-metal interaction, undulating pendant droplets are formed at the molten end, which eventually completely detach from the wire as a consequence of their increasing mass. We capture the dynamics of this process by employing a high-speed infrared camera, thereby indirectly measuring the temperature of the wire end and the pendant droplets. The time series is subsequently generated as the mean value over the pixel intensity of every infrared snapshot. Finally, we employ methods of nonlinear time series analysis to reconstruct the phase space from the observed variable and test it against determinism and stationarity. After establishing that the observed laser droplet generation is a deterministic and dynamically stationary process, we calculate the spectra of Lyapunov exponents. We obtain a positive largest Lyapunov exponent and a negative divergence, i.e., sum of all the exponents, thus indicating that the observed dynamics is deterministically chaotic with an attractor as solution in the phase space. In addition to characterizing the dynamics of laser droplet generation, we outline industrial applications of the process and point out the significance of our findings for future attempts at mathematical modeling.

Comments:	7 two-column pages, 8 figures; accepted for publication in Chaos [supplementary material available at this http URL]
Subjects:	**Chaotic Dynamics (nlin.CD)**; Dynamical Systems (math.DS); Data Analysis, Statistics and Probability (physics.data-an)
Journal reference:	Chaos 20 (2010) 013129
DOI:	10.1063/1.3367772
Cite as:	**arXiv:1003.0473v1 [nlin.CD]**

Submission history

From: Matjaz Perc [view email]

[v1] Mon, 1 Mar 2010 22:42:37 GMT (512kb)

Which authors of this paper are endorsers?