



THE UNIVERSITY OF  
MELBOURNE

# Melbourne School of Engineering Sustainable Systems Seminar

## MERIT MELBOURNE ENGINEERING RESEARCH INSTITUTE

engineering research  
for the benefit of society

### Professor Sébastien Candel

EM2C Lab, CNRS, Ecole Centrale Paris, France

Tuesday 19th August, 3pm

Theatre C1, Level 4, Block C,  
Civil Engineering, Bldg 174

4pm, Refreshments

Conference Room, Level 4, Bldg 170  
Mechanical Engineering

## Nonlinear flame dynamics and combustion instabilities.

### MORE INFORMATION

For more Sustainable Systems seminar  
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Analysis of combustion instabilities relies in most cases on linear analysis. However, observations of these processes are usually carried out in the nonlinear regime where the system oscillates at a limit cycle. The nonlinear dynamics leading to such modes of operation is investigated in the present study. The experimental setup comprises a multipoint injector where an ensemble of conical flames are anchored on a perforated plate. This layout features unstable combustion regimes resulting from a coupling between the unsteady heat release process and the burner acoustics. One observes that the flame is the main nonlinear element in the system. In other words, the gain and phase of the flame transfer function strongly depend on the acoustic modulation amplitude level. Modeling the flame response in terms of a describing function (FDF) allows to predict eigenfrequencies and oscillation amplitudes at the limit cycles. With this methodology, it is also possible to anticipate mode switching, instability triggering and hysteresis phenomena. Theoretical results deduced from the FDF methodology are in excellent agreement with measurements and the flame describing function constitutes an effective method to get insight nonlinear combustion oscillations.

Sebastien Candel obtained his engineering degree from Ecole Centrale Paris in 1968, a DEA in Plasma Physics from University of Paris 6 also in 1968, a PhD in Mechanical Engineering and Applied Mathematics from the California Institute of Technology in 1972 and a Doctorat d'Etat from University of Paris 6 in 1977. He is the recipient of many awards and honours, including the Silver medal of CNRS in 1993, the d'Aumale Prize in 1987 and the Marcel Dassault Grand Prize in 2000 both from the French Academy of Sciences, the Aeroacoustics award of the Confederation of Aerospace European Societies in 2004, the Pendray Aerospace Literature award of the American Institute of Aeronautics and Astronautics in 2005, and the "Chevalier des Palmes Académiques" in 1993. He was promoted as "Officier" in 1998, and became "Chevalier de la Légion d'Honneur" in 2000 and "Officier de l'Ordre national du Mérite" in 2006. He was awarded a "Doctorate Honoris Causa" from the University of Brussels in 2005. Since 1994 he has been a Corresponding Member of the French Academy of Sciences and became a Member of the Academy of Technology in 2000. He is a professor at Institut Universitaire de France since 2001 and holds the chair of Combustion and Propulsion. Since 1978 he has been a professor at Ecole Centrale Paris where he was head of aerospace studies (1978-2001). He now heads Mechanical and Aerospace Engineering and leads the combustion group of the EM2C laboratory (CNRS).