Welcome to the Community of Practice Webinar Series!

First, a bit of housekeeping…

- Please mute your microphone and turn off your camera
- Today’s session will be recorded
- Recordings for this and all future session will be posted on the Flight Opportunities website
- Please engage!
  - Use the chat throughout the session to ask questions
Flight Opportunities Mission

The Flight Opportunities program facilitates rapid demonstration of promising technologies for space exploration, discovery, and the expansion of space commerce through suborbital testing with industry flight providers.

Join us for future Community of Practice webinars!

Watch our website and newsletter for next month’s topic

nasa.gov/directorates/spacetech/flightopportunities/newsletter

Future webinars

• Webinars are held 1st Wednesday of each month at 10 a.m. PT
• Topics will be announced in the Flight Opportunities newsletter and website
• Session recordings will be posted on the Flight Opportunities website
• Let us know session topics you would like to see covered
Today's Speakers

Florian Chavagnat  
Ph.D. Candidate  
Massachusetts Institute of Technology (MIT)

Jason Hartwig, Ph.D.  
Research Aerospace Engineer  
NASA's Glenn Research Center

Alexander Van Dijk  
Technologist  
NASA's Flight Opportunities program
Multiphase closure modeling development for application to cryogenic boiling

January 4th Presentation

Florian Chavagnat
Massachusetts Institute of Technology
Department of Nuclear Science and Engineering

RESEARCH MOTIVATIONS

- Two major development pathways to extend the range of cryogenic engines

Orbital fuel depots

In-space re-ignitable engines

In-Situ Propellant Production

Figure: Concept of cryogenic orbital fuel/oxygen depot by NASA (1971)

Figure: Vinci ESA cryogenic rocket engine with re-ignition capability delivering on multiple orbits

Figure: Moon production of cryogenic propelant

LCH₄, LOx and LH₂
Advancing NASA Technology Priorities: Cryogenic Fluid Management

Florian Chavagnat, Ph.D. Candidate, Massachusetts Institute of Technology (MIT)
Jason Hartwig, Ph.D., Research Aerospace Engineer, NASA’s Glenn Research Center
Alexander van Dijk, Technologist, NASA’s Flight Opportunities program

January 4, 2023

Community of Practice Webinar Series
NASA Flight Opportunities

https://www.nasa.gov/directorates/spacetech/flightopportunities/community-of-practice

RESEARCH MOTIVATIONS

- How to estimate $q_{NB} = f(\Delta T_{SAT})$, in particular in microgravity?

Case of boil-off in a tank (e.g., in microgravity)

Heat input from ambient

Liq.

$\Delta T_{SAT}(x, t) = T_{wall}(x, t) - T_{sat}(t)$

Buoyancy-driven bubble departure, doesn’t apply in microgravity!

$\frac{q_{NB}}{\Delta T_{SAT}} \propto \frac{\rho (\rho_0 - \rho_f)^{1/2}}{\sigma} \Delta T_{SAT}^2$

HEAT FLUX PARTITIONING MODEL (HFP)

• HFP similar to “divide and conquer” method

Figure: General map of boiling heat transfer mechanisms
[Gilman, L. and Baglietto, E. (2017)]
HEAT FLUX PARTITIONING MODEL (HFP)

- HFP can be integrated in Multiphase-CFD codes

Figure: General map of boiling heat transfer mechanisms
[Gilman, L. and Baglietto, E. (2017)]

EXPERIMENTAL METHODS

- RedLab's CRYogenic experiment
- Apparatus in hangar
- Total mass ~1,400 lbs
EXPERIMENTAL METHODS

RedLab's CRYogenic experiment
Loading of the experiment

Apparatus in aircraft

EXPERIMENTAL METHODS

A world of experimental possibilities, e.g., saturated LN₂ flow boiling in microgravity

Nucleate Boiling (~steady-state)

Film Boiling

Quenching

Starting to input heat

Heat input stopped

Pl: Emilio Baglietto / Matteo Bucci – Nuclear Science & Engineering at MIT
Thank you!

Flight Opportunities website:
http://nasa.gov/flightopportunities

Contact us:
NASA-FlightOpportunities@mail.nasa.gov