

Agent-Based Modeling of Microbes in Space

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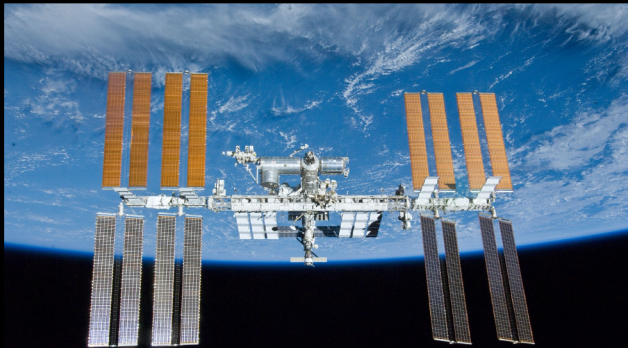
ASM Microbe 2022



5 μm

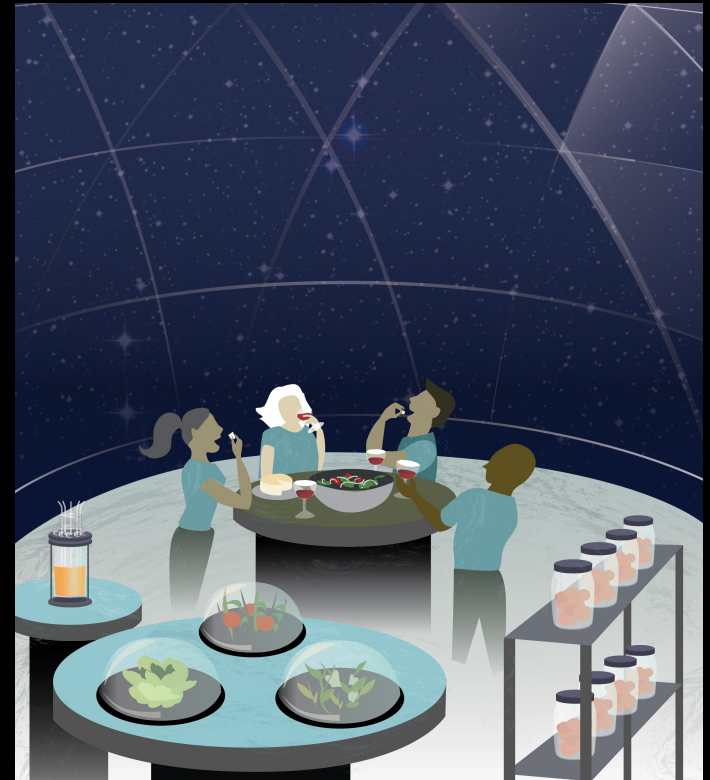
Microbes are essential to space exploration

hitchhiking as the microbiome of the built (spacecraft) environment



credit: NASA

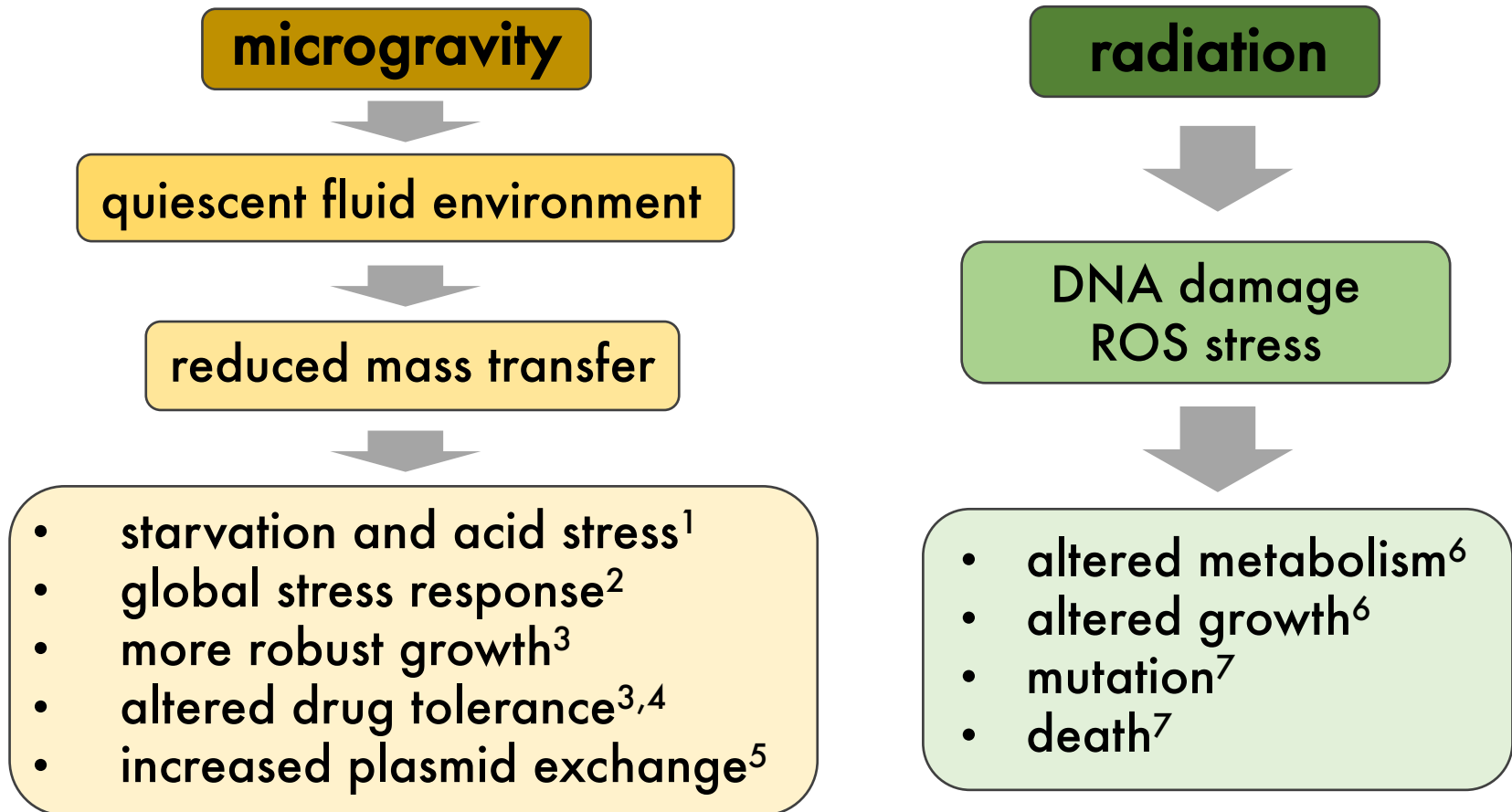
keeping astronauts healthy through microbial biotech



credit: Miki Hyunh, NASA

Space is hard for microbes

Even when shielded from desiccation, temperature extremes, and space vacuum, microbes in space habitats still experience...



1) Aunins et al. 2018, doi:10.3389/fmicb.2018.00310. 2) Wilson et al. 2007, doi: 10.1073/pnas.0707155104. 3) Zea et al. 2017, doi: 10.3389/fmicb.2017.01598. 4) Baker et al. 2004, doi:10.1007/BF02870967. 5) De Boever et al. 2007, doi: 10.1007/BF02919469. 6) Santa Maria et al. 2020, doi: 10.1089/ast.2019.2073. 7) Bijlani et al. 2021 doi: 10.1016/j.isci.2021.102395

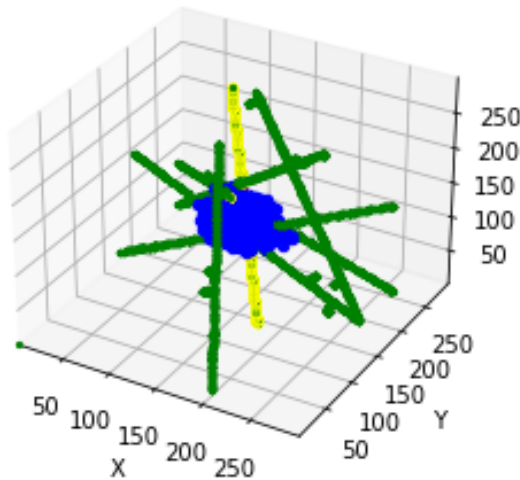
AMMPER

is the

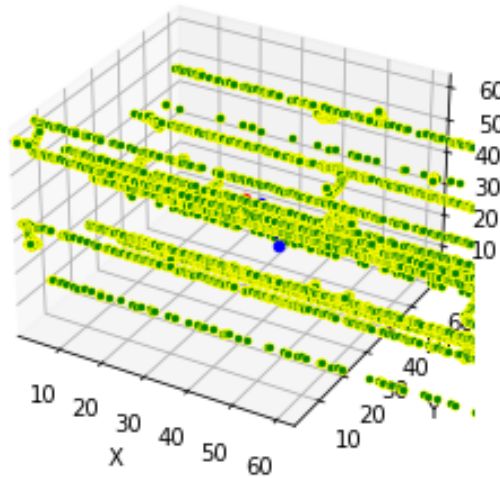
Agent-based Model for Microbial Populations Exposed to Radiation

Author: Amrita Singh (now starting PhD at CU Boulder)

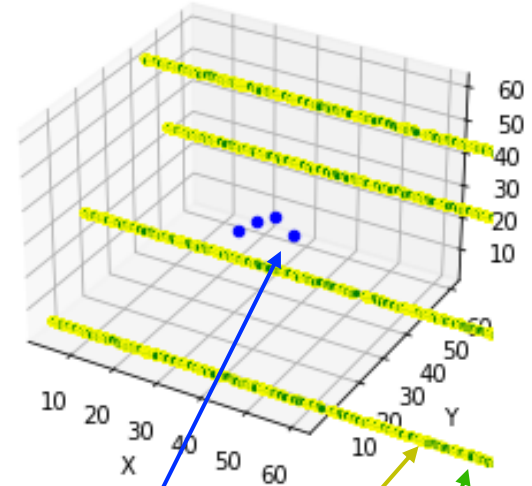
Deep Space



Accelerator
(simulated GCR)



Accelerator
(150 MeV protons)

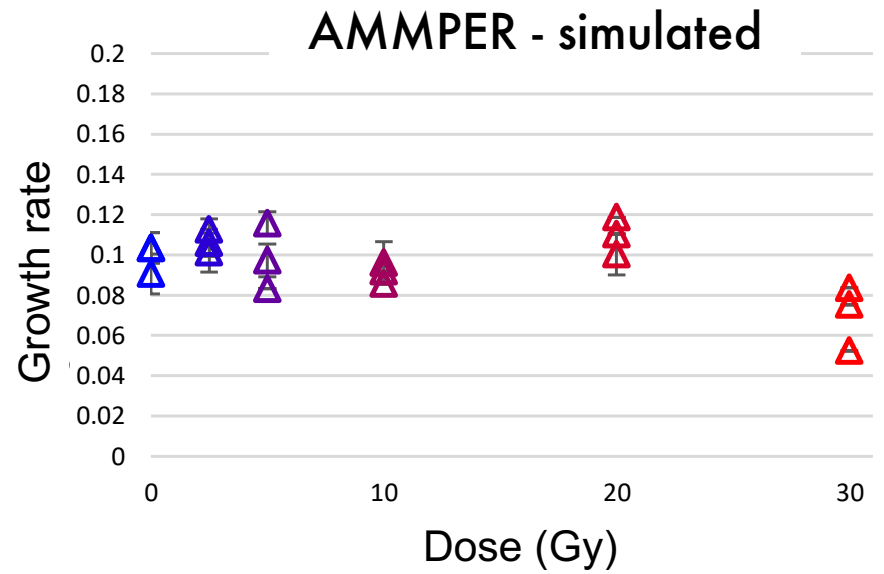
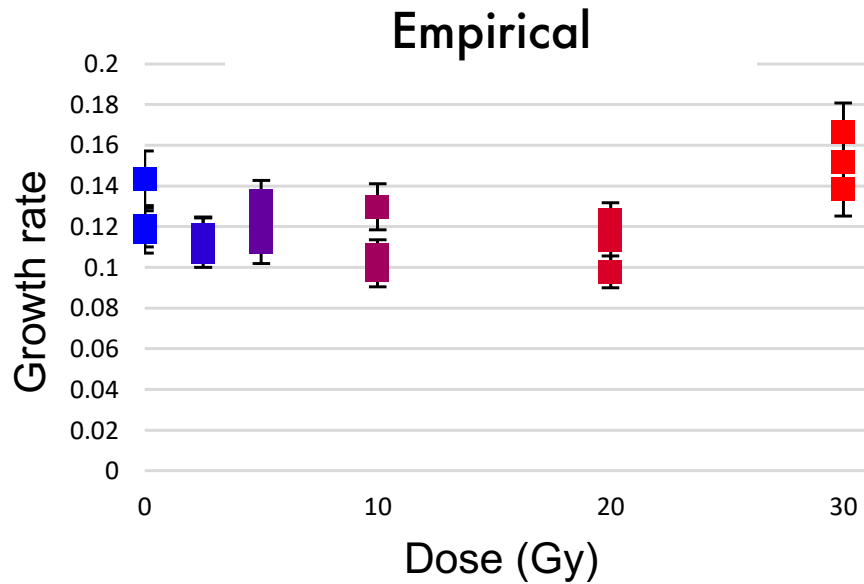


AMMPER simulates:

- yeast growth
- radiation energy deposition
- ROS generation
- cell damage and recovery

AMMPER

generates growth curves enabling comparison to wet-lab experiments

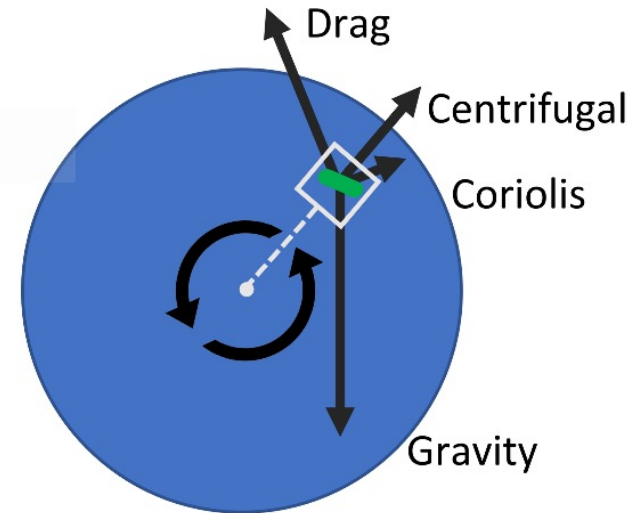
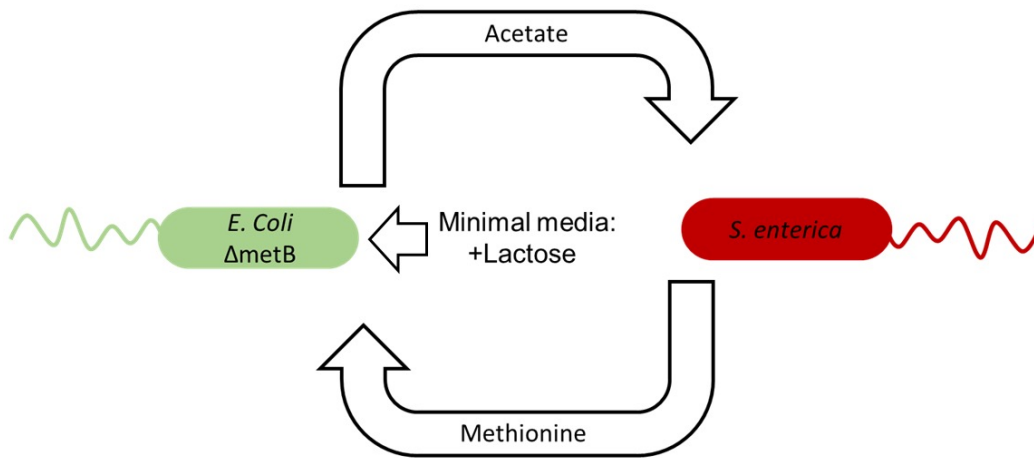


ground experiments, 150 MeV protons with WT yeast

CAMDLES

is the
CFD-DEM Artificial Microgravity Developments
for Living Ecosystem Simulation

Author: Rocky An (Junior at Cornell)



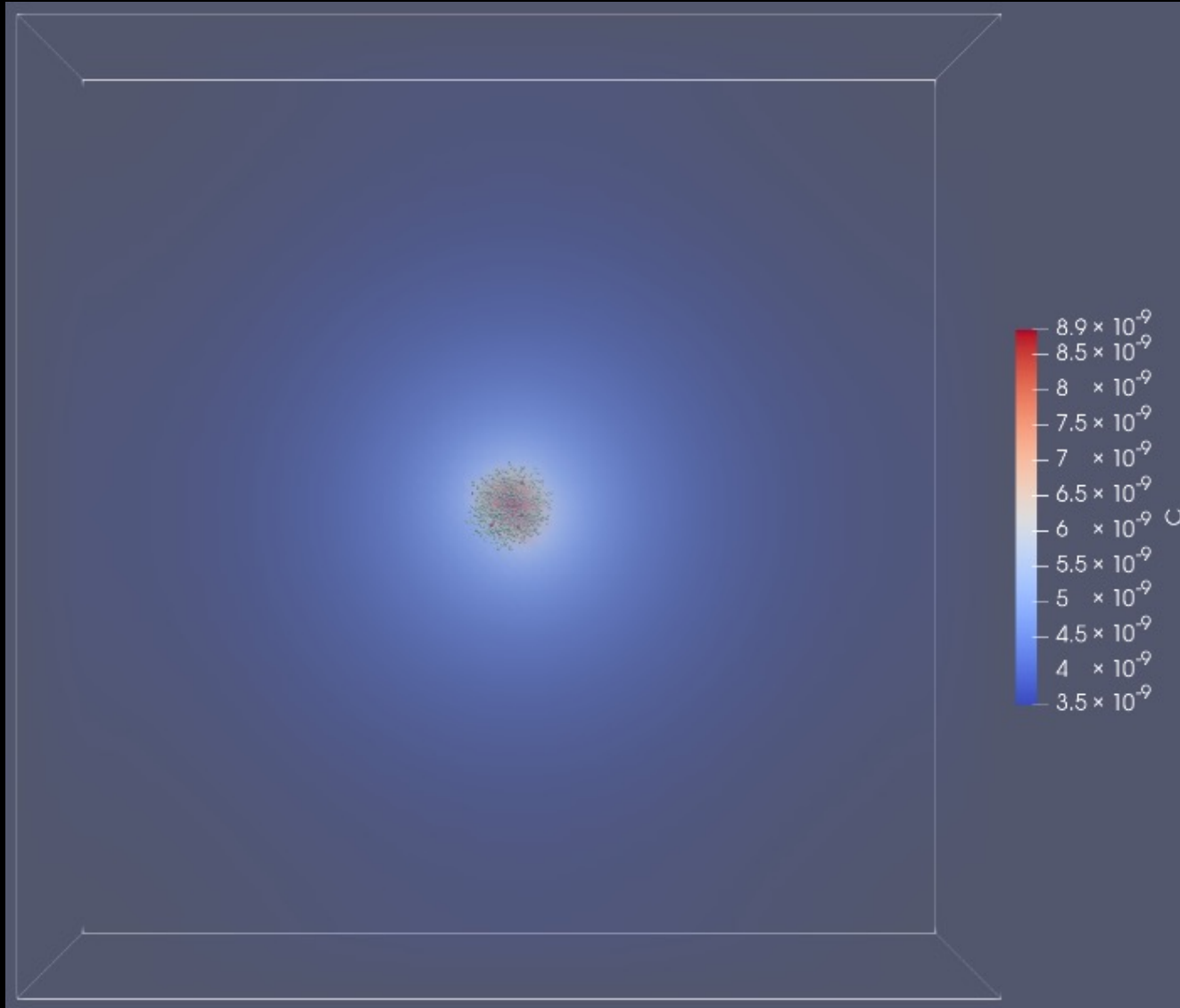
reproduced from Harcombe WR, et al. 2014. doi:10.1016/j.celrep.2014.03.070

CAMDLES simulates:

- bacterial growth
- fluid flows
- chemical fluxes

An R, Lee JA. 2022. CAMDLES: CFD-DEM Simulation of Microbial Communities in Spaceflight and Artificial Microgravity. *Life* 12:660. doi:[10.3390/life12050660](https://doi.org/10.3390/life12050660)

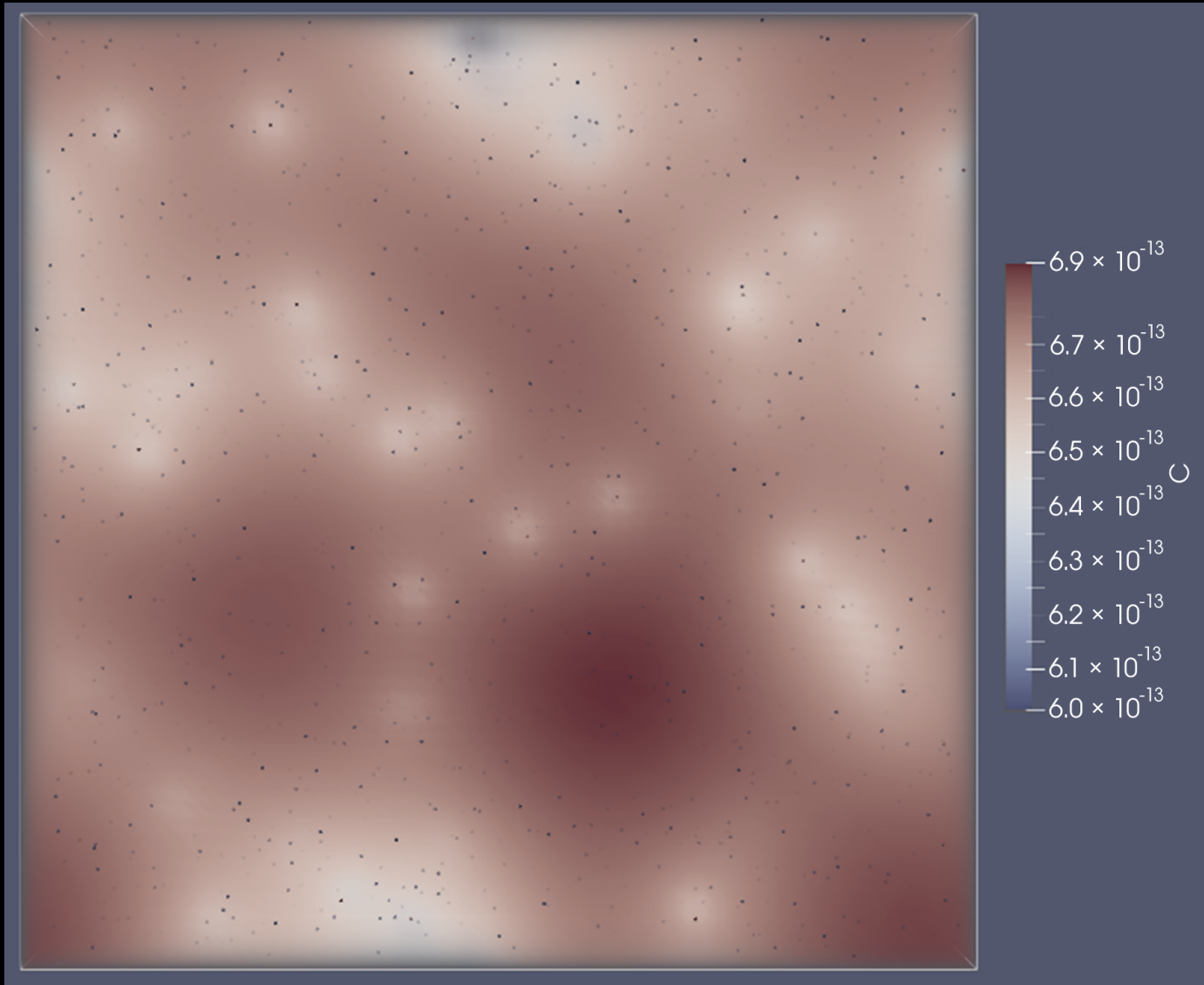
CAMDLES



A multispecies colony in microgravity

An & Lee 2022

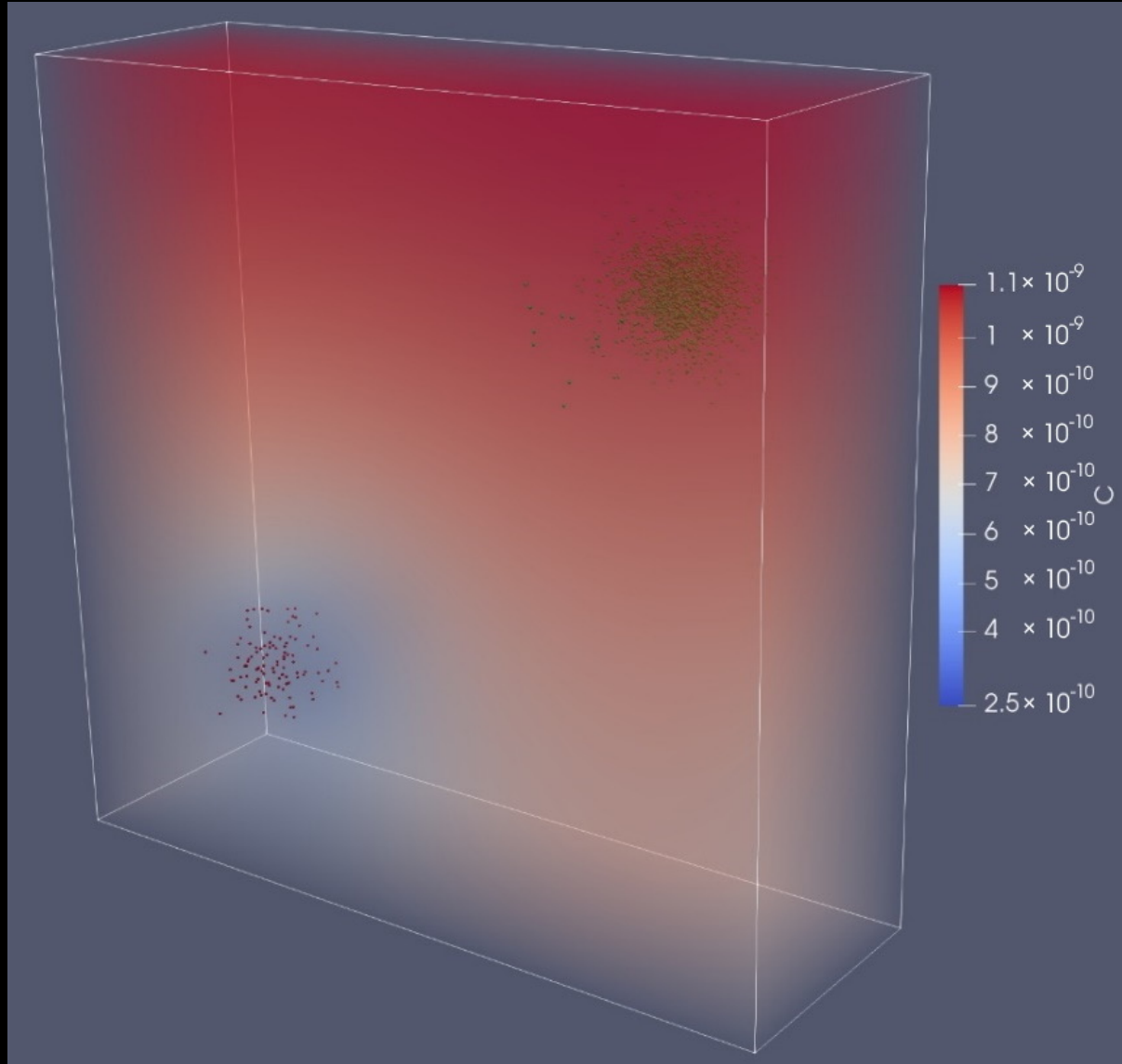
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Distributed single cells in microgravity

An & Lee 2022

CAMDLES



An & Lee 2022

Two single-species colonies in microgravity

Thank you!

AMMPER

Robert Stewart
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