September 28th, 2023

6 pm in 2241 Chamberlin Hall

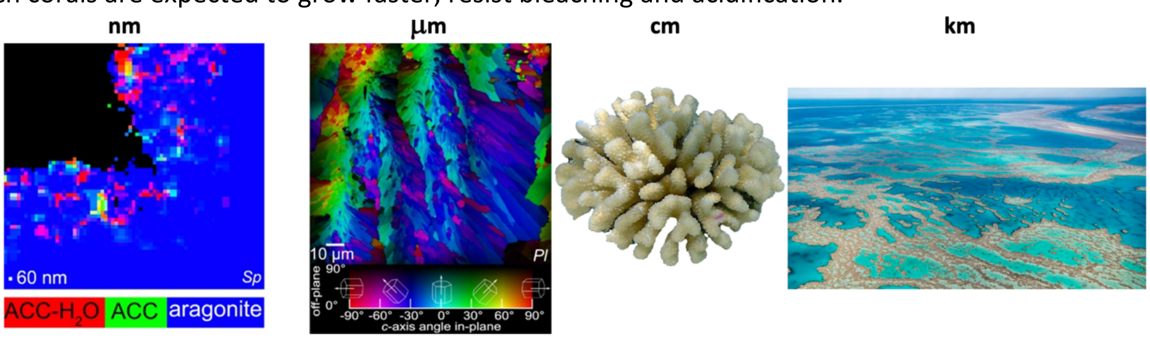
Pupa will offer **pizza** to the first 30 people arriving and give a brief talk on:

Coral biomineralization vs. climate change

Pupa Gilbert, UW-Physics and Lawrence Berkeley National Laboratory

Coral reefs cover only 1% of ocean floors, yet they host 25% of all known marine species. This incredible biodiversity is sheltered by the 3D structure of coral skeletons. My group and I revealed that corals form their skeletons by attachment of amorphous calcium carbonate (ACC) nanoparticles (1), then fill interstitial spaces by ion attachment (2). Subsequent crystallization starts as aragonite ($CaCO_3$) nanocrystals, randomly oriented and termed sprinkles, which coarsen and become radially oriented acicular crystals termed spherulites (3,4). This is Nature's 3D printing (3)! The resulting space-filling, solid, isotropic structure grows slowly (0.5-5.0 cm/year) to form m-km coral reefs visible from outer space.

Corals are threatened by climate change, including ocean warming and acidification. With acidification, the solubility of $CaCO_3$ increases, thus, making it increasingly difficult for corals to build their skeletons, especially because the ACC transient precursor phase is more soluble than aragonite (5). Different coral species are differently sensitive to ocean acidification, indicating that mechanistic biological factors link ocean chemistry and $CaCO_3$ mineral growth, which we are studying. My group's research suggests two science-based interventions to help coral reefs. First, species selection based on resilience to acidification (6) may allow repopulation of damaged reef ecosystems. Second, we are building electrified grids on which corals are expected to grow faster, resist bleaching and acidification.



1. T Mass, AJ Giuffre, C-Y Sun, CA Stifler, MJ Frazier, M Neder, N Tamura, CV Stan, MA Marcus, PUPA Gilbert. Amorphous calcium carbonate particles form coral skeletons. *Procs Natl Acad Sci* **114**, E7670-E7678 (2017). DOI: https://doi.org/10.1073/pnas.1707890114
2. C-Y Sun, CA Stifler, RV Chopdekar, CA Schmidt, G Parida, V Schoeppler, BI Fordyce, JH Brau, T Mass, S Tambutté, PUPA Gilbert. From particle attachment to space-filling coral skeletons *Procs Natl Acad Sci* **117**, 30159-30170 (2020). DOI: https://doi.org/10.1073/pnas.2012025117
3. C-Y Sun, MA Marcus, MJ Frazier, AJ Giuffre, T Mass, PU Gilbert. Spherulitic growth of coral skeletons and synthetic aragonite: Nature's three-dimensional printing. *ACS Nano* **11**, 6612–6622 (2017). DOI: https://pubs.acs.org/doi/10.1021/acsnano.7b00127
4. C-Y Sun, L Gránásy, CA Stifler, T Zaquin, RV Chopdekar, N Tamura, JC Weaver, JAY Zhang, S Goffredo, G Falini, MA Marcus, T Pusztai, V Schoeppler, T Mass, PUPA Gilbert. Crystal nucleation and growth of spherulites demonstrated by coral skeletons and phase-field simulations. *Acta Biomater* **120**, 277-292 (2021). DOI: https://doi.org/10.1016/j.actbio.2020.06.027
5. PUPA Gilbert, KD Bergmann, N Boekelheide, S Tambutté, T Mass, F Marin, J Adkins, J Erez, B Gilbert, V Knutson, M Cantine, J Ortega Henrandez, AH Knoll. Biomineralization: integrating mechanism and evolutionary history *Science Advances* **8**, 1-16 (2022). DOI: https://www.science.org/doi/10.1126/sciadv.abl9653
6. CA Schmidt, CA Stifler, EL Luffey, BI Fordyce, A Ahmed, G Barreiro Pujol, CP Breit, SS Davison, CN Klaus, IJ Koehler, IM LeCloux, C Matute Diaz, CM Nguyen, V Quach, JS Sengkhammee, EJ Walch, MM Xiong, E Tambutté, S Tambutté, T Mass, PUPA Gilbert. Faster crystallization during coral skeleton formation correlates with resilience to ocean acidification. *J Am Chem Soc* **144**, 1332-1341 (2022). DOI: https://doi.org/10.1021/jacs.1c11434