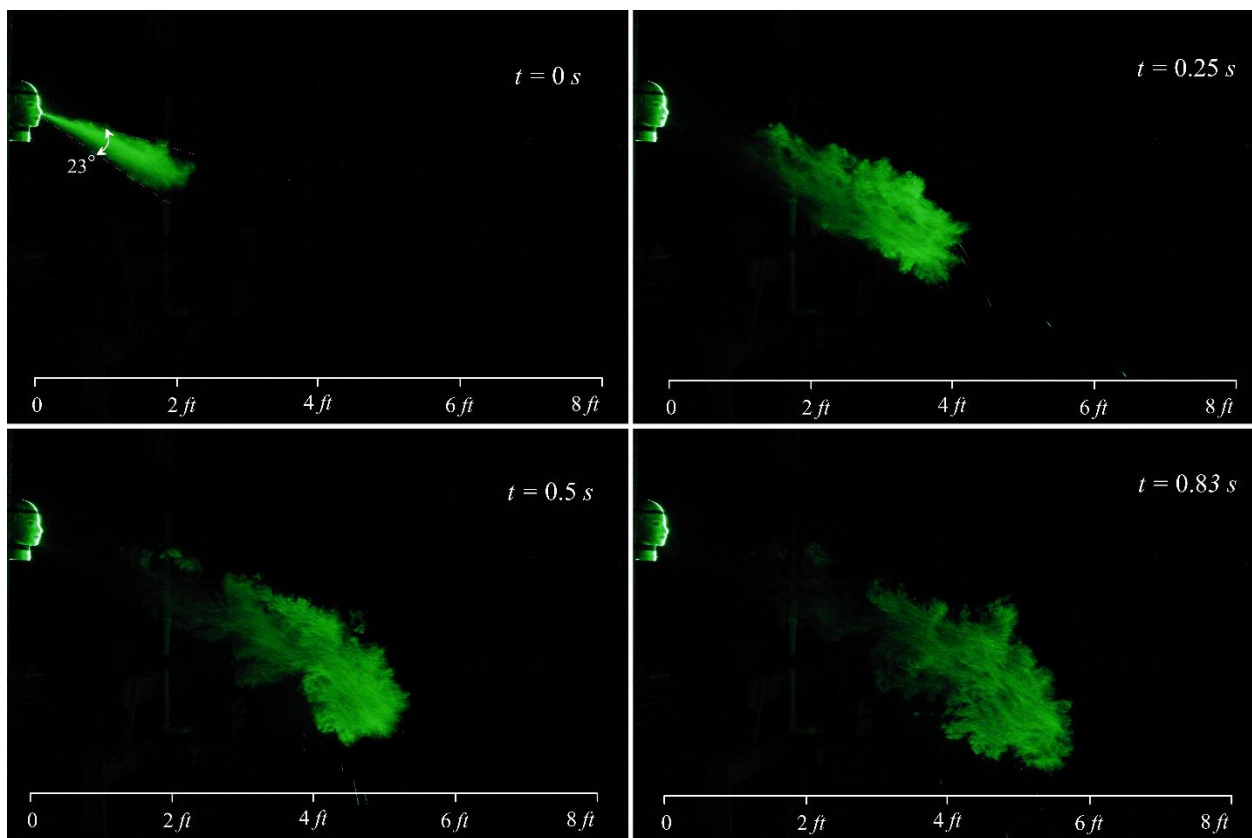


# Experimental Visualization of Sneezing and Efficacy of Facemask and Shields

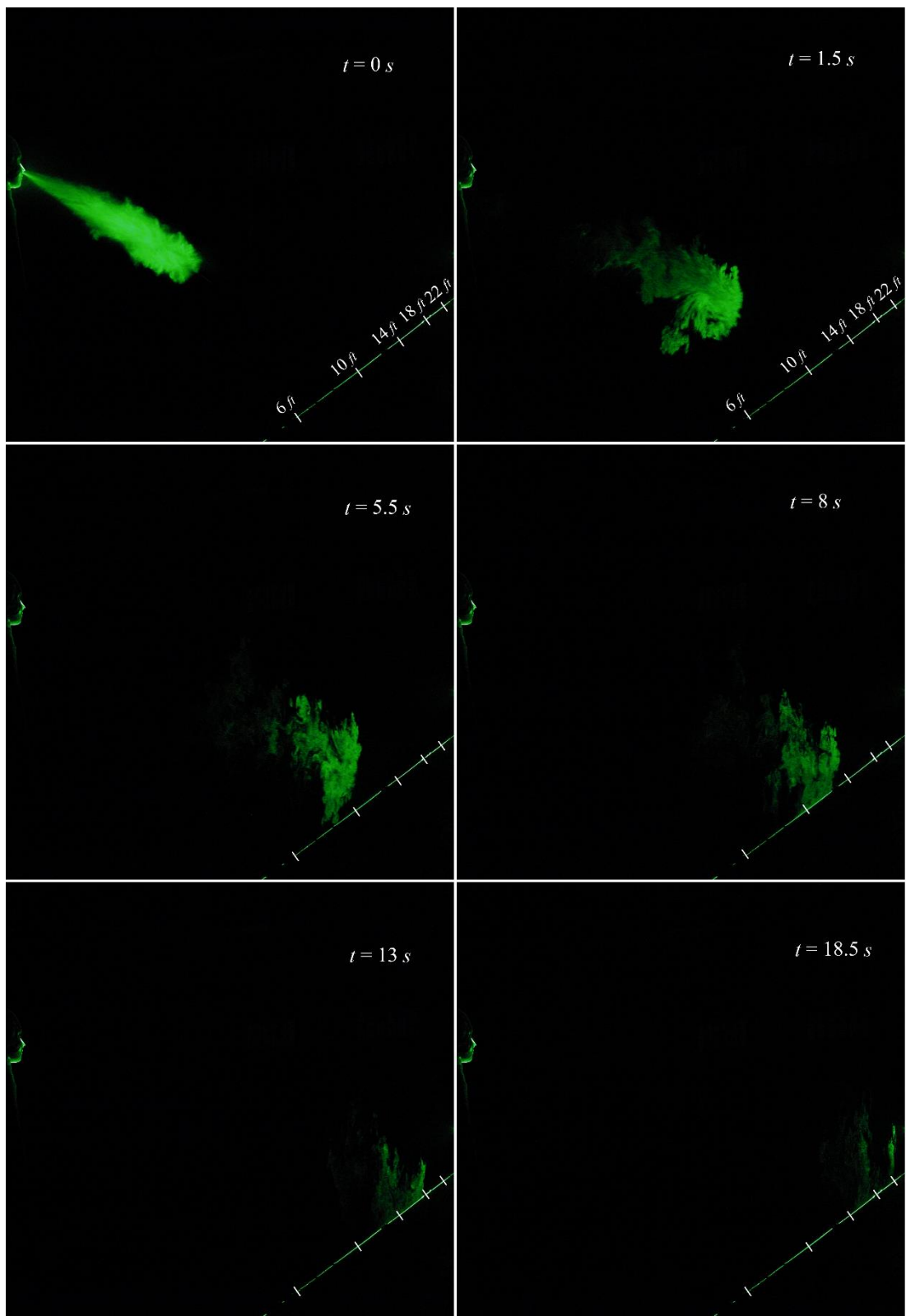
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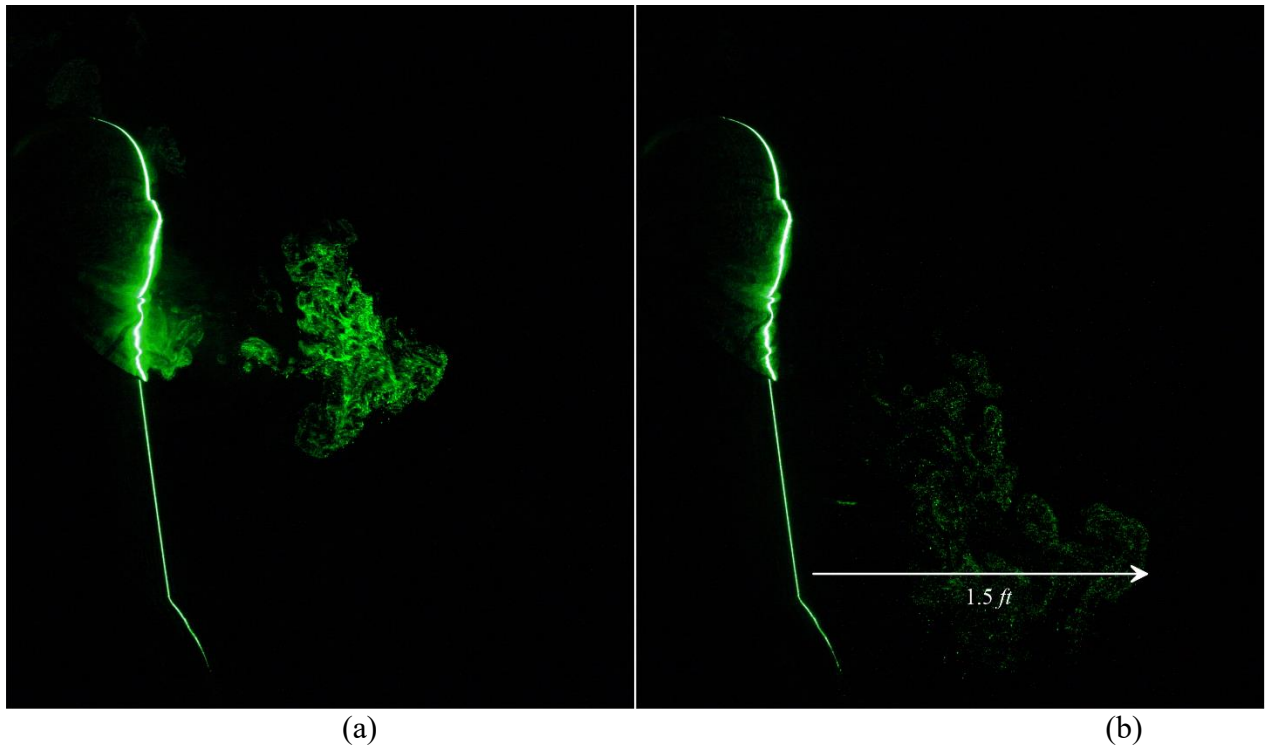
We propose and demonstrate a simple experimental visualization to simulate sneezing by maintaining dynamic similarity with actual sneezing. A typical sneeze can travel up to 25 ft in  $\sim 22$  sec in a stagnant environment. Protective measures like face mask are effective in blocking the leakage of droplets. Our study demonstrates that a three-layer homemade mask is just adequate to impede the penetration of fine-sized particles, which may cause the spreading of the infectious pathogen responsible for COVID-19. However, a surgical mask cannot block the sneeze, and the sneeze particle can travel up to 2.5 ft in a stagnant environment. We strongly recommend using at least a three-layer homemade mask with a social distancing of 6 ft to combat transmission of COVID-19 virus. A combination of a face mask and face shield is useful in preventing the spreading of droplets in offices. We strongly recommend using the elbow or hand to prevent droplets leakage even after wearing a mask during sneezing and coughing.



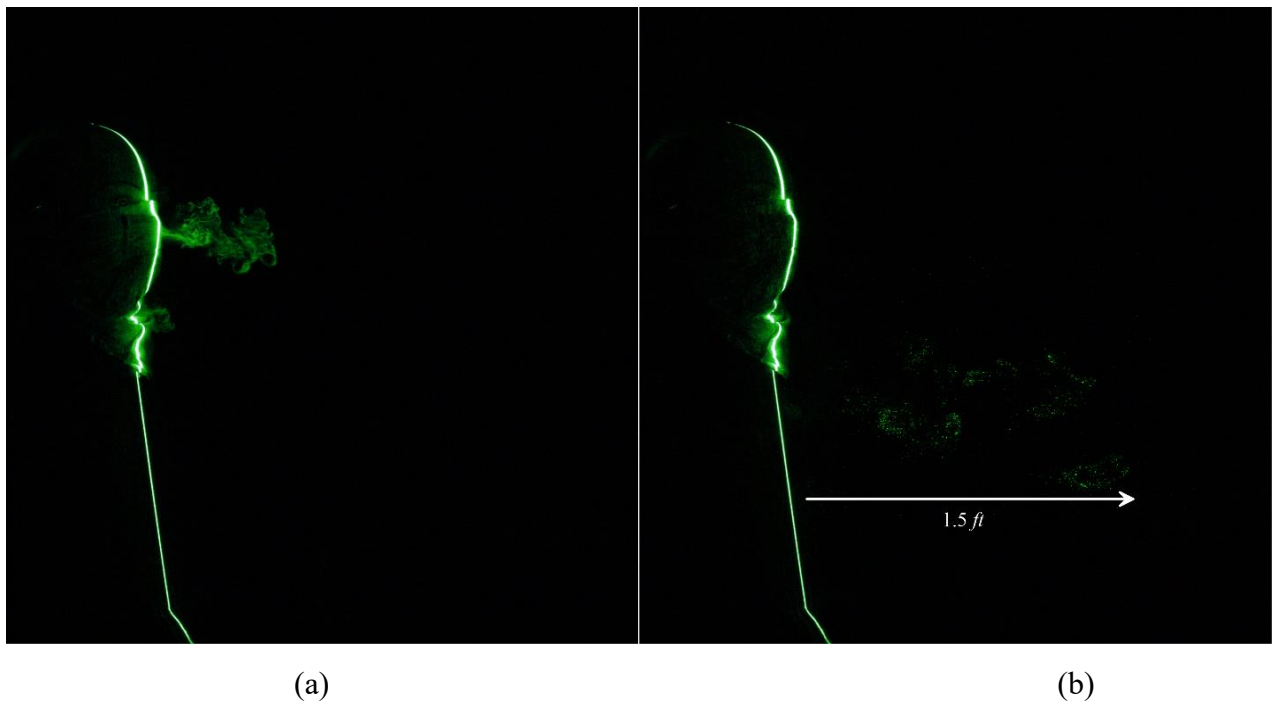
Evolution of a sneeze



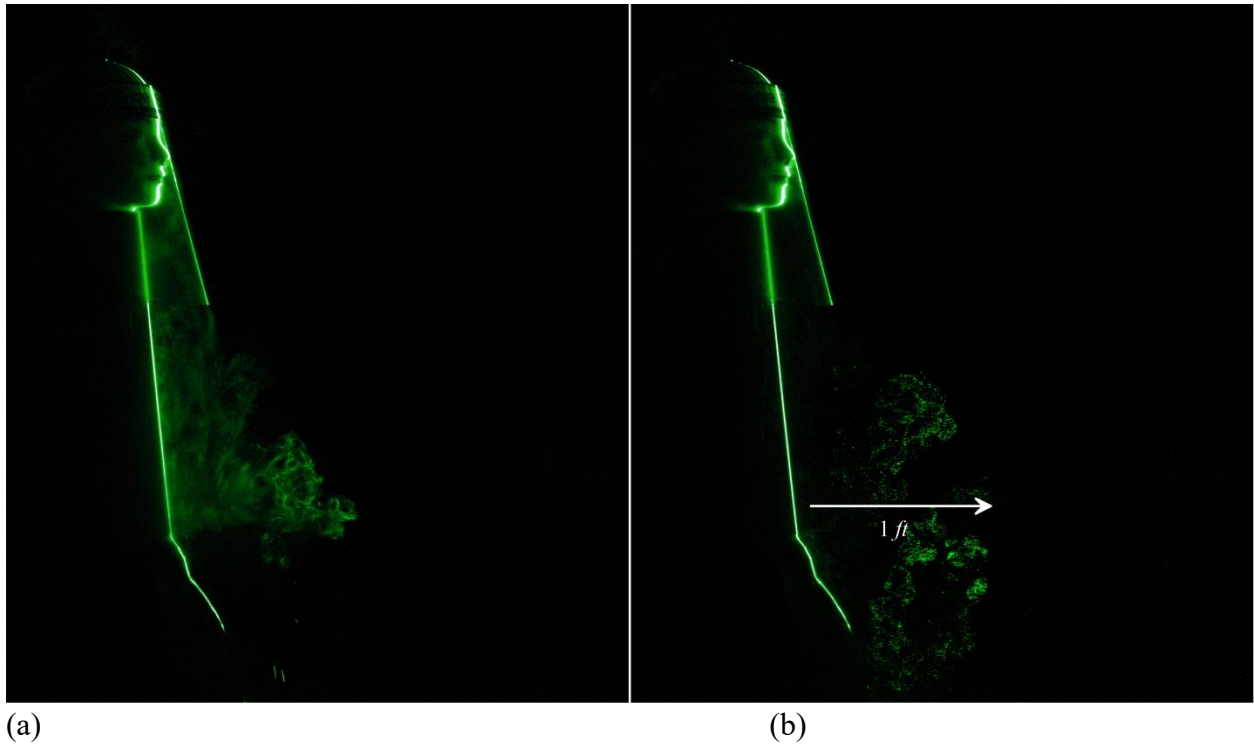
Reach of the sneeze



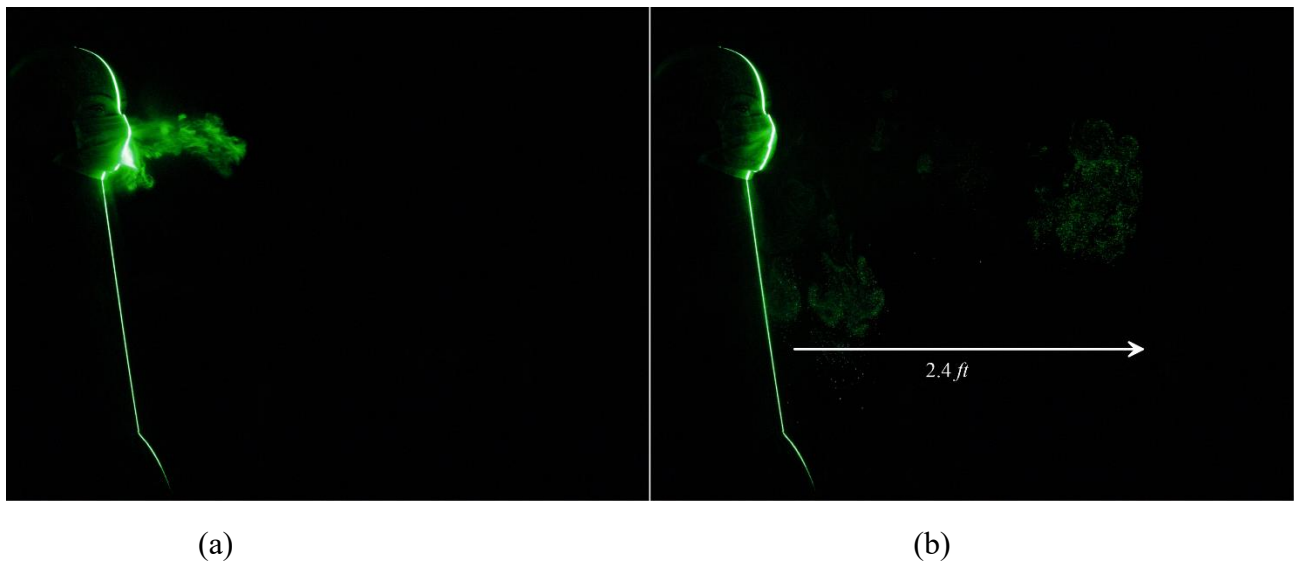
Leakage of a human sneeze from a two-layered triangle mask can travel to 1.5 ft. (a)  $t = 0.7\text{s}$  and (b)  $t = 1.95\text{ s}$  after emanating sneeze



Escape of human sneeze from a three-layer mask. The particles travel up to 1.5 ft. (a)  $t = 0\text{ s}$  and (b)  $t = 3.1\text{ s}$  after the emanation of sneeze



Escape of human sneeze from a plastic face shield can travel to 1 ft. (a)  $t = 0$  s and (b)  $t = 0.6$  s after the emanation of a sneeze.



Leakage of sneeze particles from a surgical mask. (a)  $t = 0$  s and (b)  $t = 1.35$  s after the emanation of sneeze.

TABLE 1. Summary of different masks, types of material used, number of layers or threads/inch present, and the average distance travel by the tracer particles beyond which it's presence is unnoticeable

| Type of mask                      | Material                 | Number of layers or Threads/inch | Average distance traveled by a sneeze                                                                     |
|-----------------------------------|--------------------------|----------------------------------|-----------------------------------------------------------------------------------------------------------|
| Without mask                      | ...                      | ...                              | ~ 25 ft                                                                                                   |
| Two-layered mask                  | Cotton                   | 50 threads/inch                  | ~ 1.5 ft                                                                                                  |
| Three-layered mask                | Cotton                   | 65 threads/inch                  | ~ 1.5 ft                                                                                                  |
| Face shield                       | Polycarbonate            | ...                              | ~ 1 ft                                                                                                    |
| Two-layered mask with face shield | ...                      | 50 threads/inch                  | ~0.5 ft                                                                                                   |
| Surgical mask                     | Polypropylene            | 3 layered                        | ~ 2.5 ft                                                                                                  |
| Surgical mask with face shield    | ...                      | ...                              | ~ 0.4 ft                                                                                                  |
| N-95                              | Synthetic polymer fibers | 5 layered                        | 0 ft in the forward direction<br><br>~ 2 ft in the backward direction (Due to leakage from top and sides) |