Fairbanks Weather Phenomena

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CS 485
(Fall 2022)

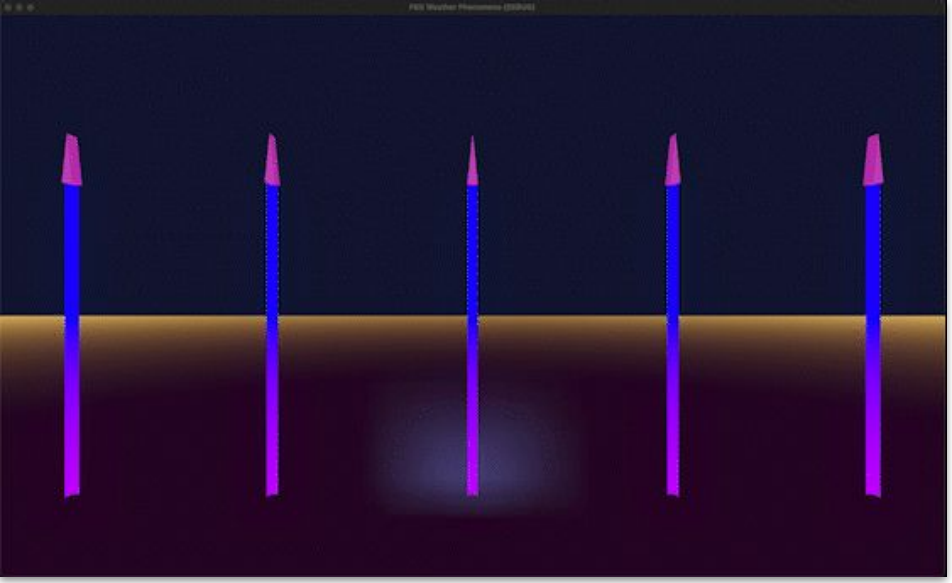
Light Pillars & Ice Fog

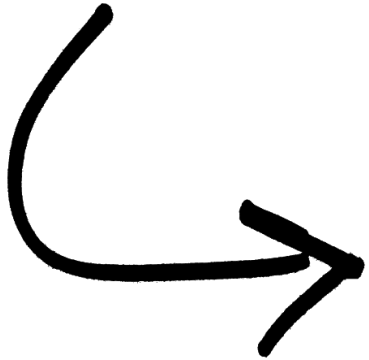
⇒ Godot Representation

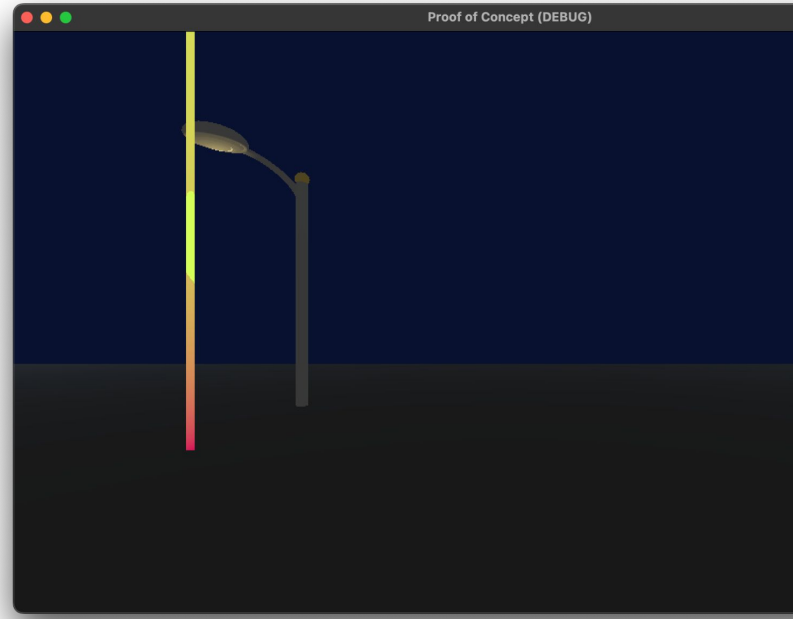
Initial Idea

- Which object(s) could best be represent given lights within a scene?
  - How many?
  - At what angle?
  - Where do the edges begin/end?
- Reflection vs. refraction (tiny ice crystals)
  - Vertically stacked mirrors floating in the atmosphere → light source → radiant column
    - Upper latitudes: low sun angle & temperature

Image Credit: National Weather Service Fairbanks (Left / Right)







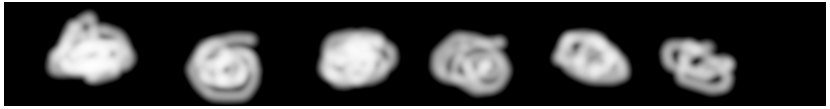
Street Lamp Example

Project Demo

```
float ray_cylinder_intersection(vec3 C,vec3 D) {
    float h = 50.0; // Height
    float r = 0.25; // Radius

    // Translate the ray to the cylinder's coordinate system.
    C.x -= 17.5;

    // Solve quadratic equation for intersection with cylinder.
    float a = dot(D,D) - dot(D,lightDirection)*dot(D,lightDirection);
    float b = 2.0*(dot(D,C) - dot(D,lightDirection)*dot(C,lightDirection));
    float c = dot(C,C) - dot(C,lightDirection)*dot(C,lightDirection) - r*r;

    float disc = b*b - 4.0*a*c;
    if (disc<0.0) return -1.0; // No intersection.
    float t = (-b - sqrt(disc))/(2.0*a);

    // Check if intersection is within cylinder.
    vec3 world = C + t*D;

    if (abs(world.y)>h) return -1.0; // No intersection.
    return t;
}
```

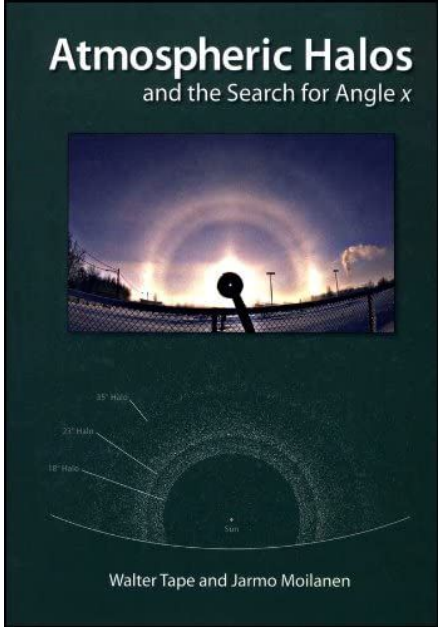
Lessons Learned + Next Steps

- Inverted [normal] → cull 2D object
  - Solution: subsection of shape ✅
- Utilize the asset library for inspiration!
  - GIMP for fog representation ☁️
- Scalability via differing light sources (e.g. street lamp color temperature)
  - Feathered edges of cylindrical objects as smooth surfaces 🪶



Further Reading

- *Atmospheric Halos and the Search for Angle x*
  - Walter Tape & Jarmo Moilanen
- *Physically Based Rendering of Ice Crystal Halos*
  - Arthur Pereira Vala Firmino
- 3.3 Cylinders — *Physically Based Rendering*
  - Matt Pharr, Wenzel Jakob, & Greg Humphreys



7.1 Future Work

As mentioned above, to lower rendering times sampling methods other than rejection sampling should be investigated. One standard method [1] would be to pre-compute a lower resolution marginal distribution function, as well as cumulative distribution function. These would then be used to importance sample the phase function.

Questions?

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