

Procedural Sound Synthesis within Unity

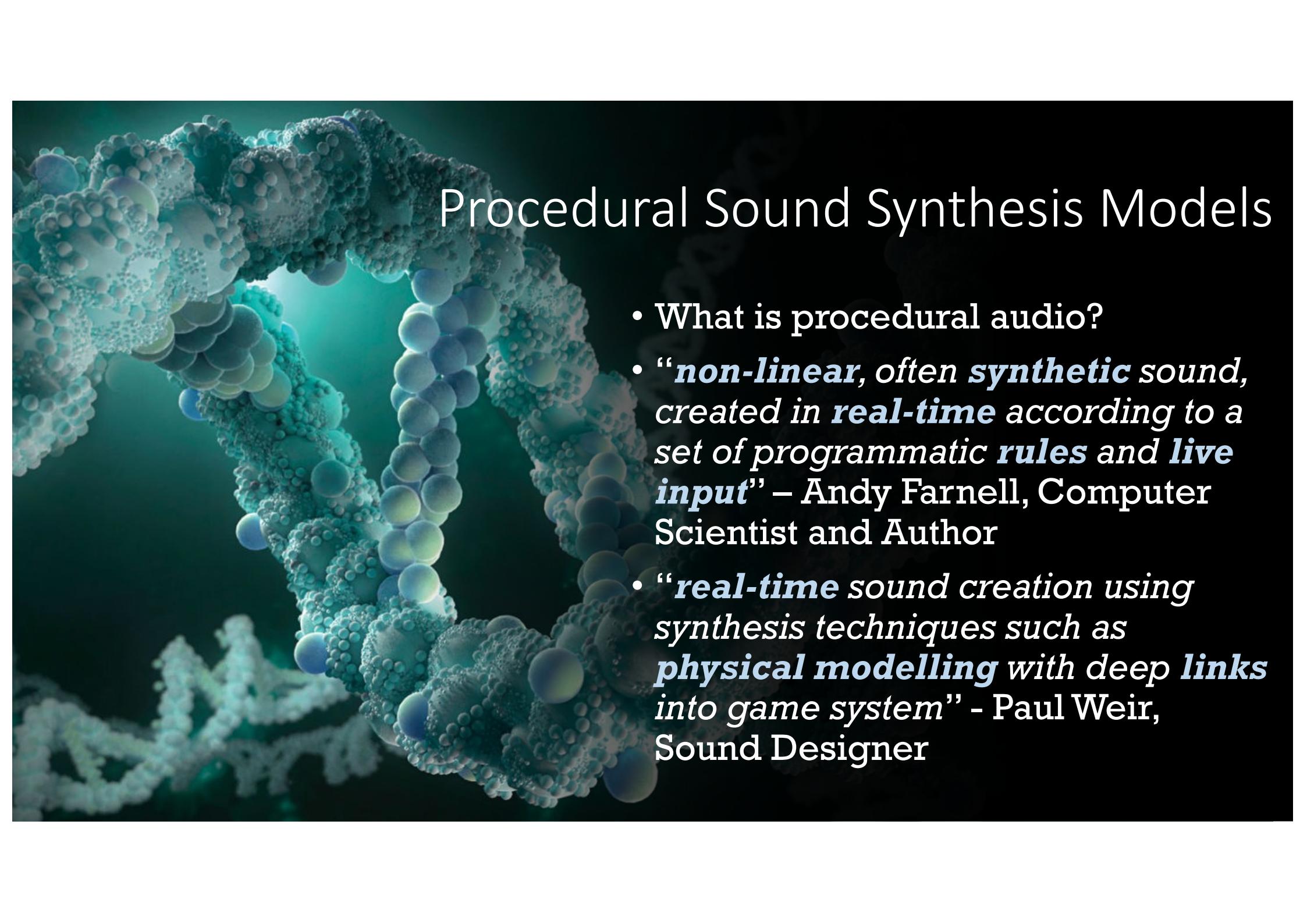
Balandino Di Donato & Rod Selfridge

Edinburgh Napier University

Outline

- Introduction
- Background
- Procedural Audio
- Physically Inspired Sound Synthesis
- Aeroacoustics
- Basic Sword Model
- Unity implementation



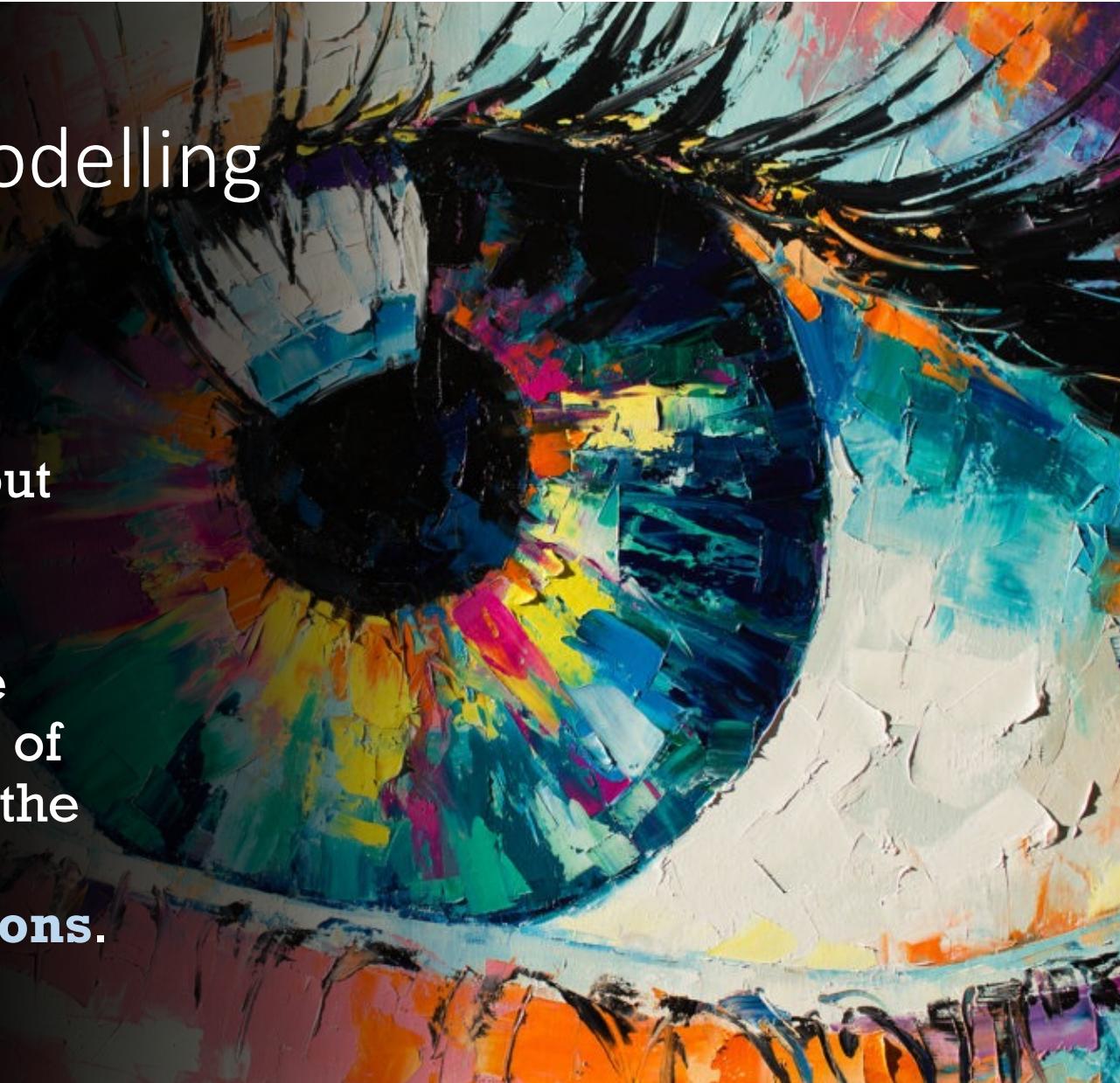


Procedural Sound Synthesis Models

- What is procedural audio?
- “***non-linear, often synthetic sound, created in real-time according to a set of programmatic rules and live input***” – Andy Farnell, Computer Scientist and Author
- “***real-time sound creation using synthesis techniques such as physical modelling with deep links into game system***” - Paul Weir, Sound Designer

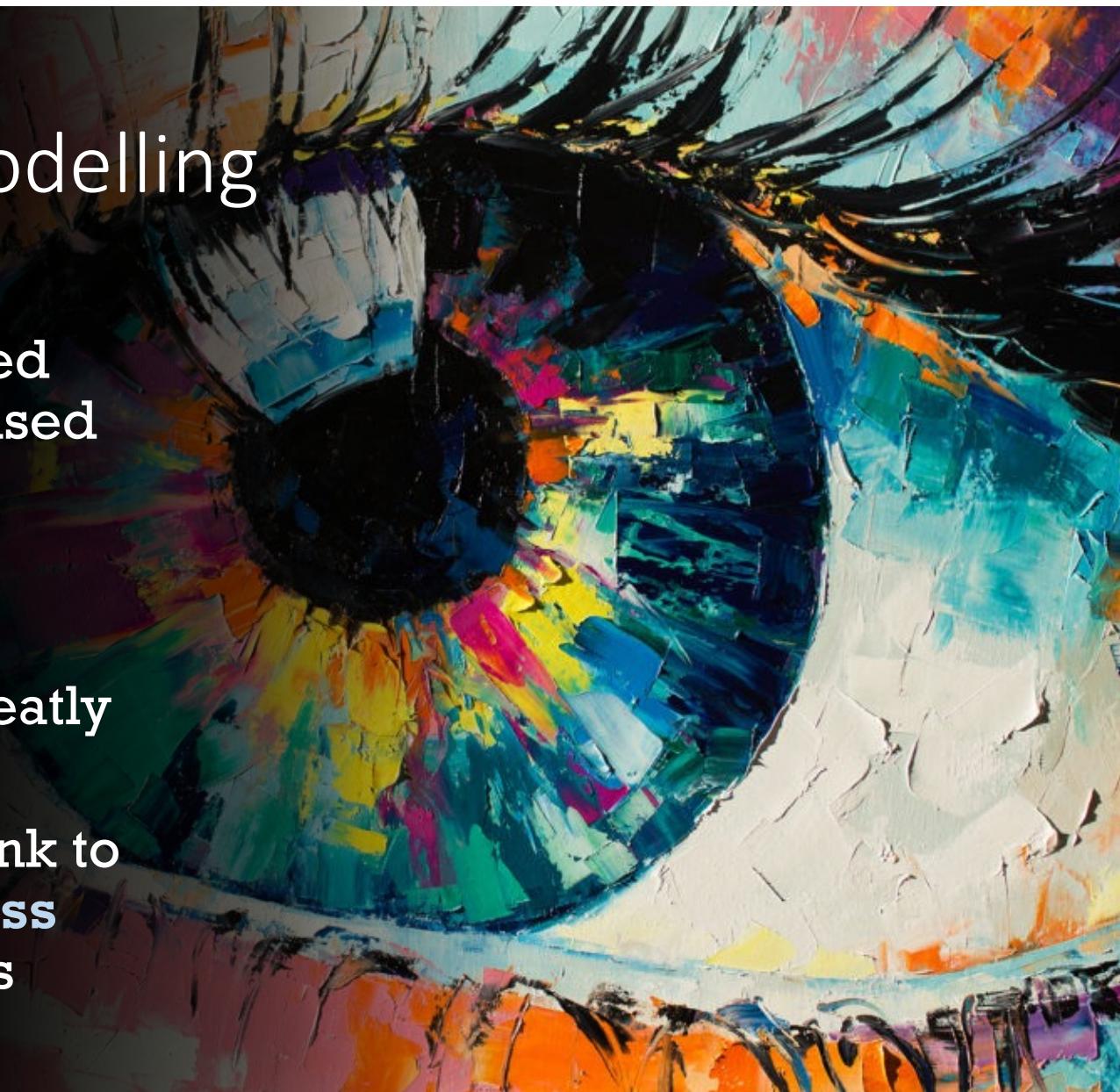
Physically Inspired Modelling

- The models have **some understanding** of physical processes and behaviours but to a lesser extent than full physical models.
- An advantage of some of the **approximations** of the laws of physics often made are that the models often require considerably **less calculations**.



Physically Inspired Modelling

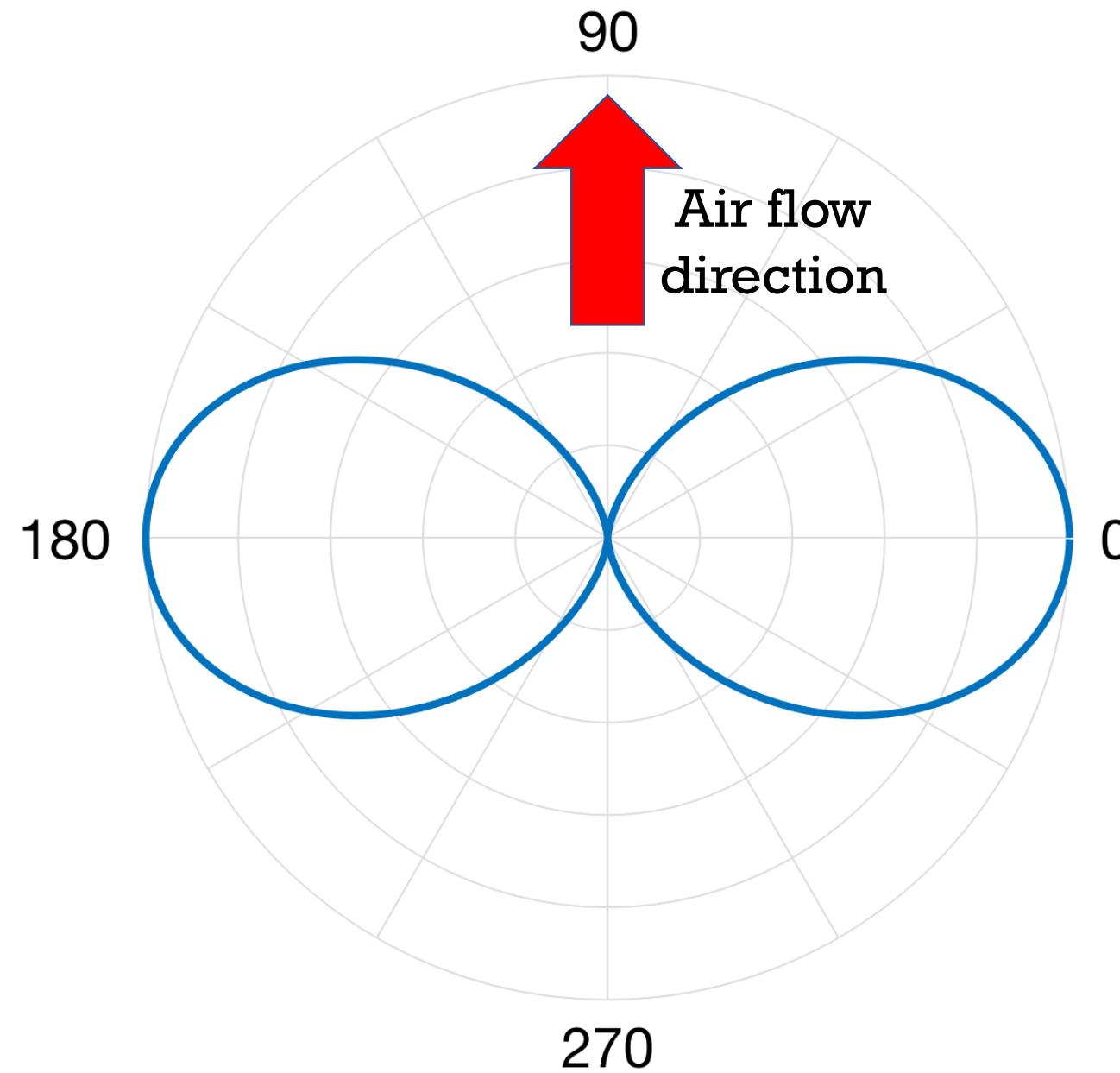
- The synthesis techniques used are often the same as those used in **signal-based** methods
 - Noise shaping
 - Additive synthesis
- **Parameterisation** varies greatly between models
- Parameters can have close link to the sound **generating process** and **behaviour** of the models



Compact Sound Sources

- **Hypothetical** concept of different **small** sound producing objects which are used to **model** actual sounds generated
- Main three
 - Monopoles
 - **Dipoles**
 - Quadrupoles



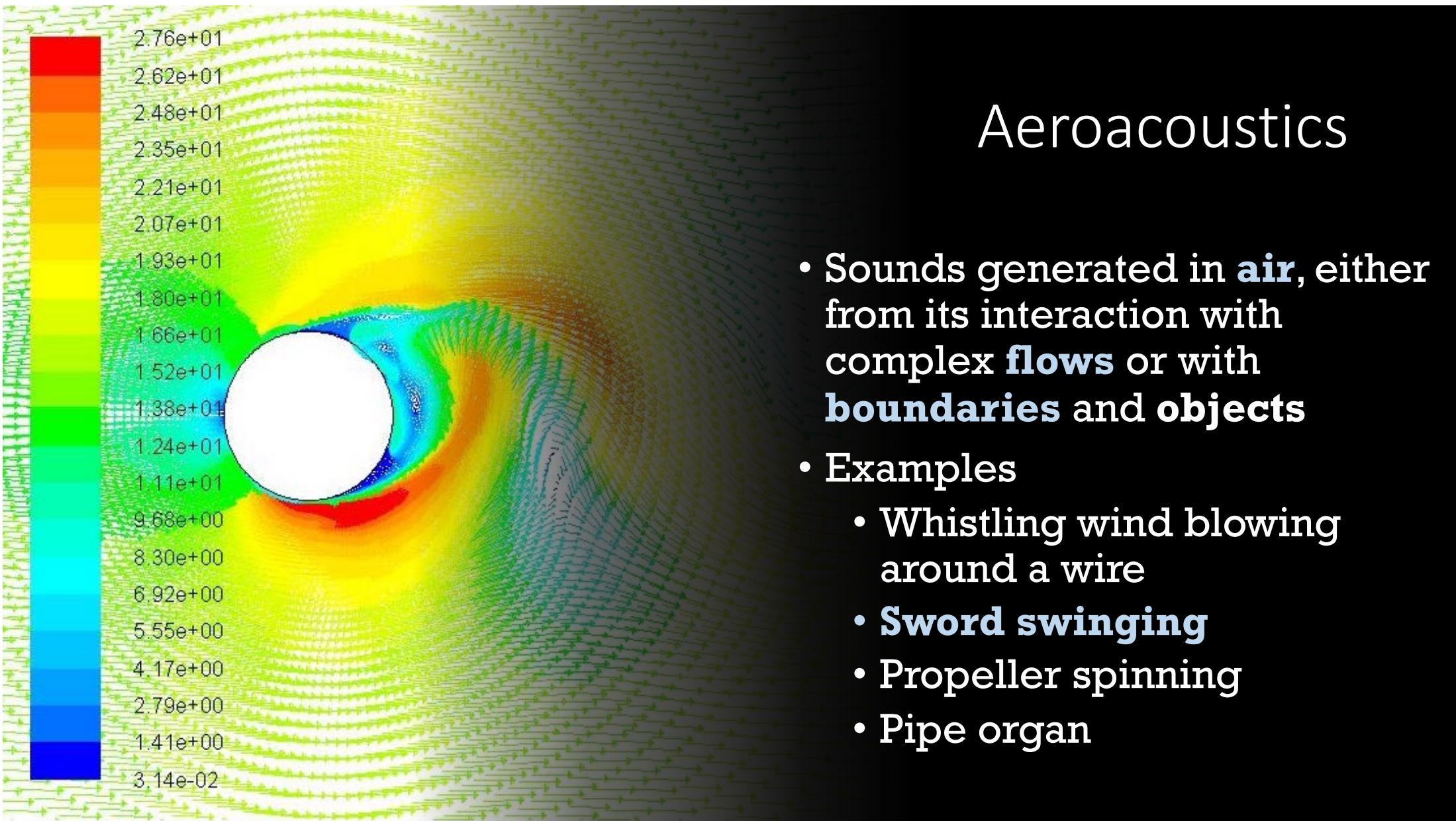


Dipole

- Each side of the dipole is in **opposite phase** to the other
- Can be thought of as a **sphere pulsing** from side to side and is again much **smaller** than the acoustic wavelength

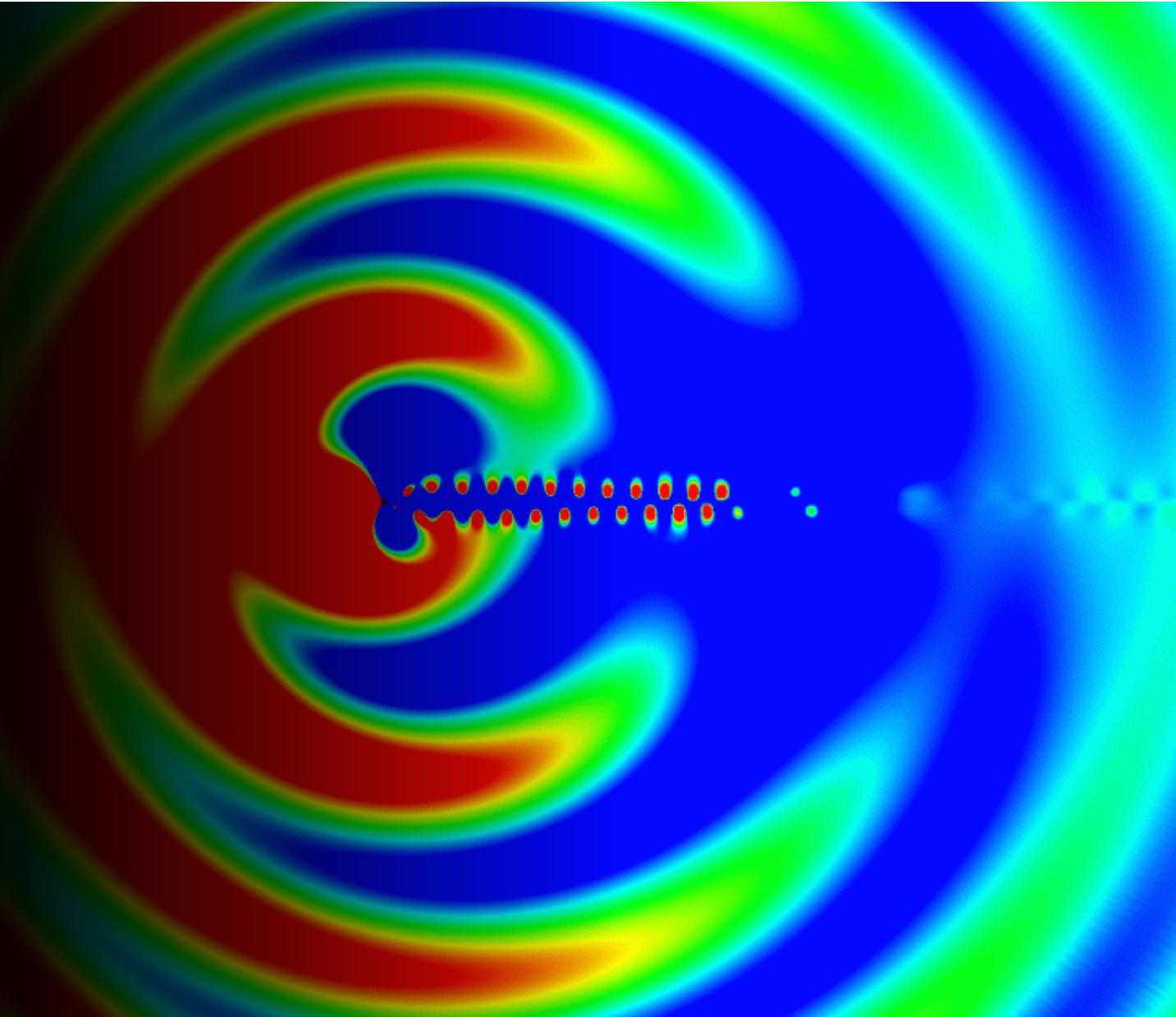
Aeroacoustics

- Sounds generated in **air**, either from its interaction with complex **flows** or with **boundaries** and **objects**
- Examples
 - Whistling wind blowing around a wire
 - **Sword swinging**
 - Propeller spinning
 - Pipe organ

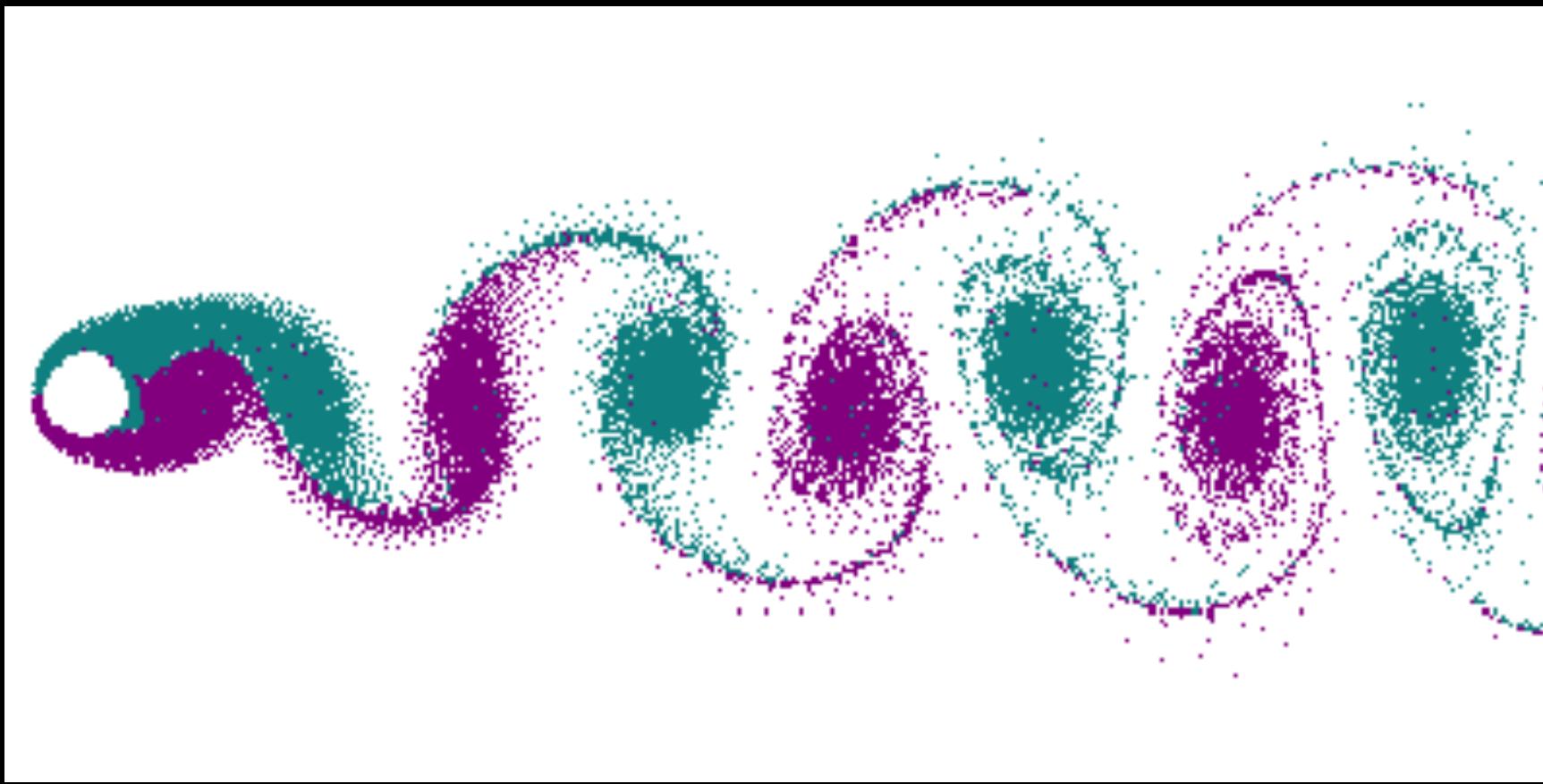


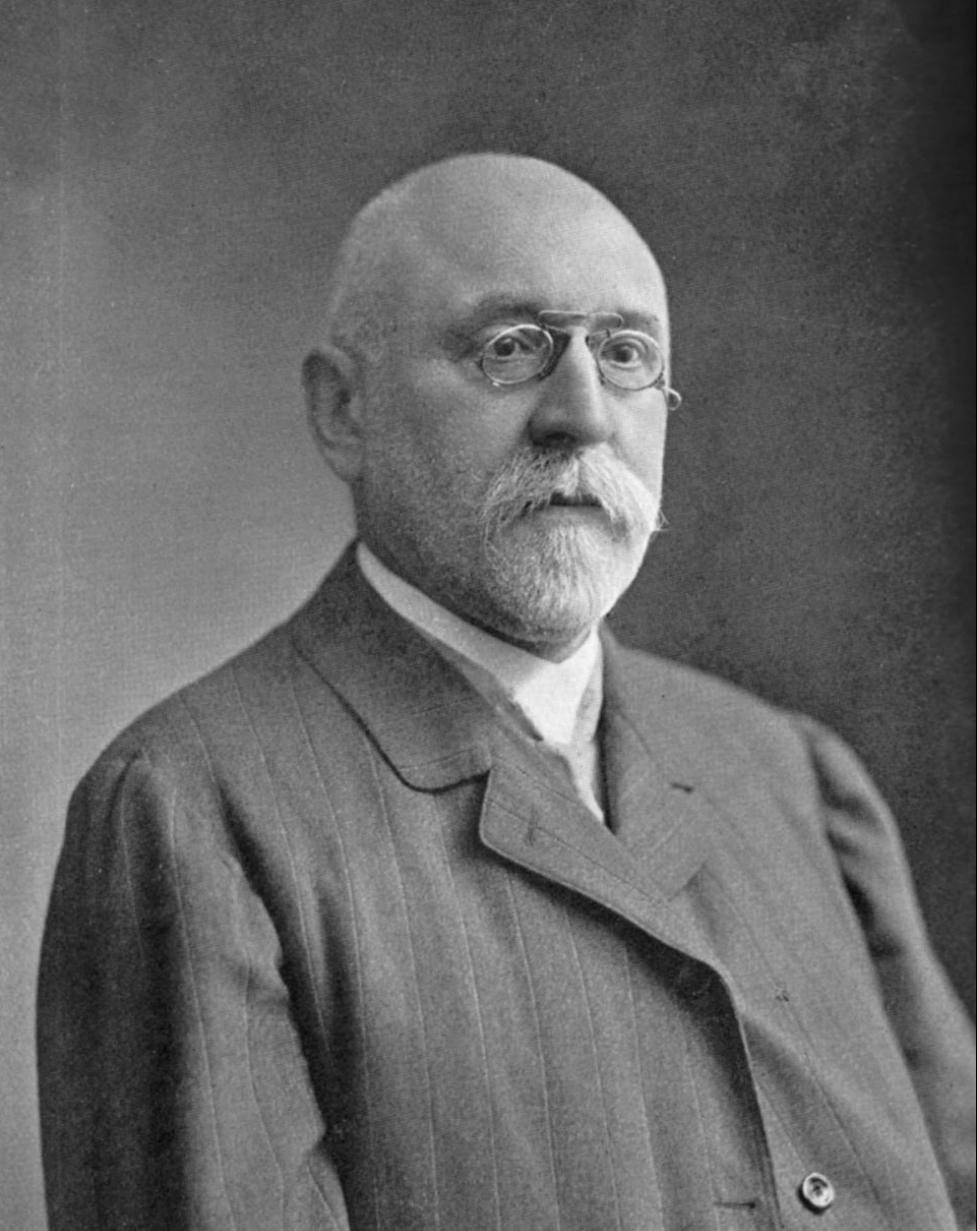
Aeolian Tone

- When air flows around an object and an aeroacoustic tone generated it is known as the **Aeolian tone**
- Most frequently studied object is a **cylinder** due to its uniform structure and common use in design



Vortex Street



A black and white portrait of Vincenc Strouhal, a Czech physicist. He is shown from the chest up, wearing a dark suit jacket over a light-colored shirt. He has a full, grey beard and mustache, and is wearing round-rimmed glasses. His hair is thinning on top. The background is a plain, light color.

Vincenc Strouhal

- Czech physicist who carried out first major study into Aeolian tones in **1878**
- Spun an arm which had a cylindrical wire at the end
- Measured the tone **frequency** for a known **airspeed** and cylinder **diameter**
 - $St = (\text{freq} \times \text{diameter}) / \text{air speed}$
 - **St** approx. 0.2 (closer to 0.189)

Aeolian Tone Gain

- For the Aeolian tone,
proportional to airspeed to the
power of 6

$$\text{Acoustic Intensity} \propto u^6 \sin^2 \theta$$

- Also, proportional to the square
of the elevation

Pure data patches

<https://github.com/balandinodidonato/AM22-Procedural-Audio-for-Virtual-Environments>

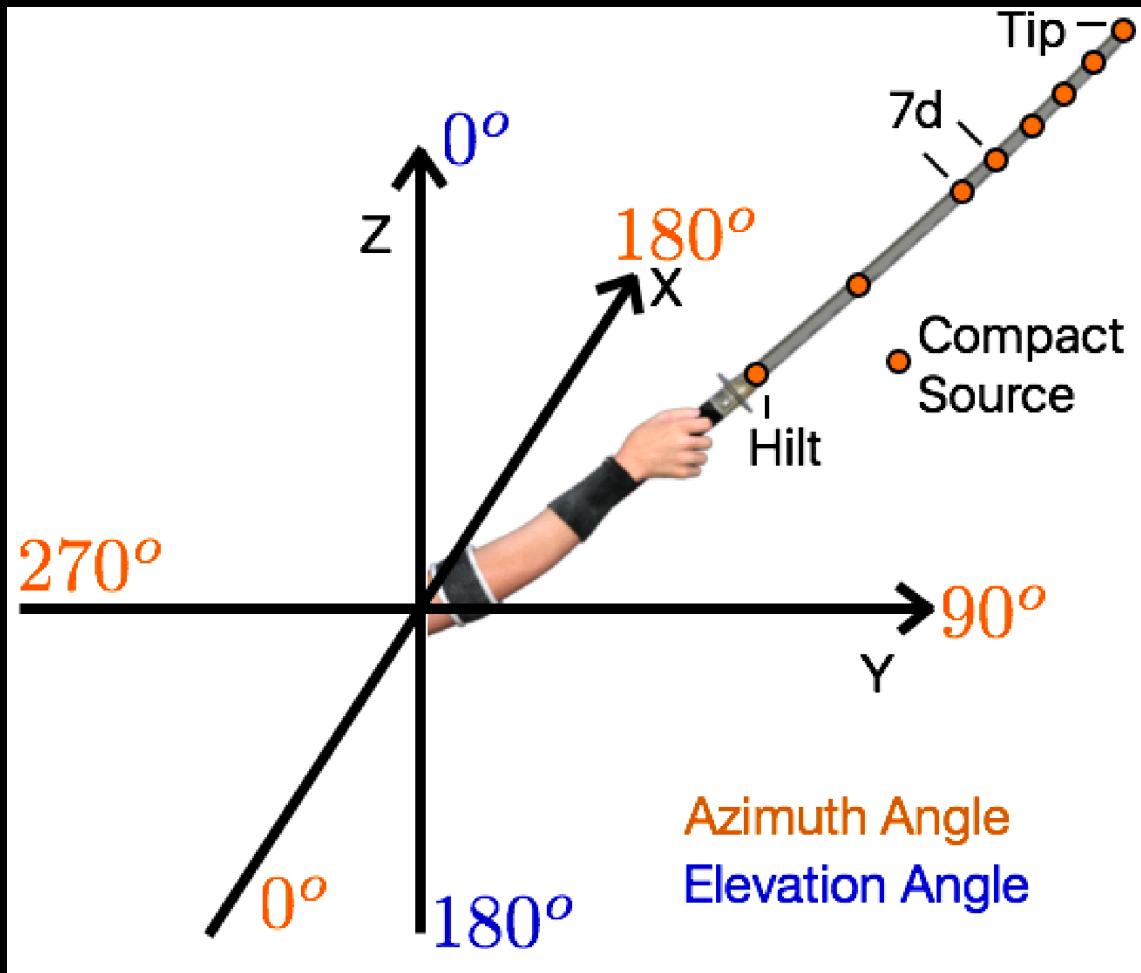
BE CAREFUL WITH YOUR EARS

What we have not included

$$\overline{I_l(t)} \sim \frac{\sqrt{2\pi} \kappa^2 S_t^2 l b \rho u^6 \sin^2 \theta \cos^2 \varphi}{32 c^3 r^2 (1 - M \cos \theta)^4}$$
$$\left\{ \exp \left[-\frac{1}{2} \left(\frac{2\pi M S_t l}{d} \right)^2 \sin^2 \theta \sin^2 \varphi \right] \right\}$$

- Reynolds Number
 - Measure of turbulence
 - Based on viscosity and density of air
 - Has affect on the Strouhal Number
 - Bandwidth of filters proportional to Reynolds Numbers
- Azimuth angle
 - Sound sources are not 2D but 3D objects

What we have not included



- More than one sound source
- Gain is proportional to the length of the cylinder
- Doppler effect
- Drag dipole
- Wake noise
- Harmonics

Extended pure data patches

<https://github.com/balandinodidonato/AM22-Procedural-Audio-for-Virtual-Environments>

Cyclone, iemlib and zexy externals required.

BE CAREFUL WITH YOUR EARS