

Airborne Transmission of Covid-19

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The Concept

- ▶ Covid 19 virus reported to the World Health Organization (WHO) on December 31, 2019.
- ▶ Reduce/Prevent its spread
- ▶ Cemosis and Synapse-Concept project 4fastsim-ibat.
- ▶ Air quality since Covid-19.

Collaboration Cemosis/Synapse

Airborne
Transmission of
Covid-19

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- ▶ Cemosis created in January 2013 by Christophe Prud'homme.
- ▶ Strasbourg Centre for Modelling and Simulation.
- ▶ Synapse-Concept created in November 1999.
- ▶ Specialised in engineering and technical studies.

- ▶ Study of the airborne transmission of COVID-19 in an indoor space.
- ▶ The air in the room follows an advection-diffusion-reaction equation.
- ▶ With only one infectious person in the room.
- ▶ Room of size $8m(l) \times 8m(w) \times 3m(h)$.
- ▶ Breathing/Talking with and without a face mask.

- ▶ Firstly, 2D model to study/reproduce the concentration of airborne infectious particles.
- ▶ Using the advection–reaction–diffusion equation.
- ▶ Assumptions :
 - particles released from the infected person with zero initial velocity.
 - transported via advection due to the airflow in the room and diffusion due to turbulent mixing
 - the advection velocity of the air, $v(m/s)$ controlled by the air-conditioning unit.
 - the recirculation of air leads to turbulent mixing of the infectious particles.

- ▶ Hence, the advection–reaction–diffusion equation :

$$\frac{\partial C}{\partial t} = \nabla \cdot (K \nabla C) - \nabla \cdot (\vec{v} C) + S.$$

- ▶ C = concentration of airborne infectious particles
 t = time
 ∇ = two-dimensional gradient operator
 K = isotropic eddy diffusion coefficient (turbulent diffusion)
 \vec{v} = advection velocity of the air
 S = sum of sources and sinks of viral particles.

- ▶ Secondly, using «N-point ASOM» (air supply opening model).
- ▶ Developed in 2003 by Bin Zhaoa, Xianting Lib and Qisen Yanb at Tsinghua University, Beijing, China.
- ▶ Replace the real diffuser by several simple openings, maintaining the inlet momentum and mass flows.

The Tools

- ▶ Feel++ to solve advection–reaction–diffusion equation.
- ▶ Paraview to visualize the solution.
- ▶ Antora to generate the documentation site.
- ▶ Visual Studio Code.

- ▶ Z. Lau, K. Kaouri, I. Griffiths. Modelling Airborne Transmission of COVID-19 in Indoor Spaces Using an Advection–Diffusion–Reaction Equation. School of Mathematics, Cardiff University and Mathematical Institute, University of Oxford.
- ▶ B. Zhao and X. Li. A simplified system for indoor airflow simulation. Building and Environment · April 2003
- ▶ Zohra Djatouti, Christophe Prud'homme, Vincent Chabannes, Romain Hild IBat Website
- ▶ https://twitter.com/T_Fiolet/status/1378989583682179075?s=09