Virtual Forum for Knowledge Exchange in the Mathematical Sciences (V-KEMS)

ECMI2021 – MS09

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New official UK ECMI partner

Newton Gateway to Mathematics

- the knowledge exchange arm of the Isaac Newton Institute - a key part of the UK national infrastructure for mathematical sciences
- provides a national network for knowledge exchange
- note that Jane Hutton and Martine Barons (speaking next) are also part of this network.

https://www.vkemsuk.org/home

What is VKEMS ?

An informal UK network formed at the start of the COVID19 lockdown interested in taking mathematical science knowledge exchange activities online

formed late March 2020

Links with other initiatives

SAGE

Juniper

SPI-M

RAMP (cont.)

V-KEMS

IDP

THE ROYAL SOCIETY

Isaac Newton Institute for Mathematical Sciences

Newton Gateway to Mathematics

ICMS

ktn

Science Base

Industry, Third-sector and OGDs

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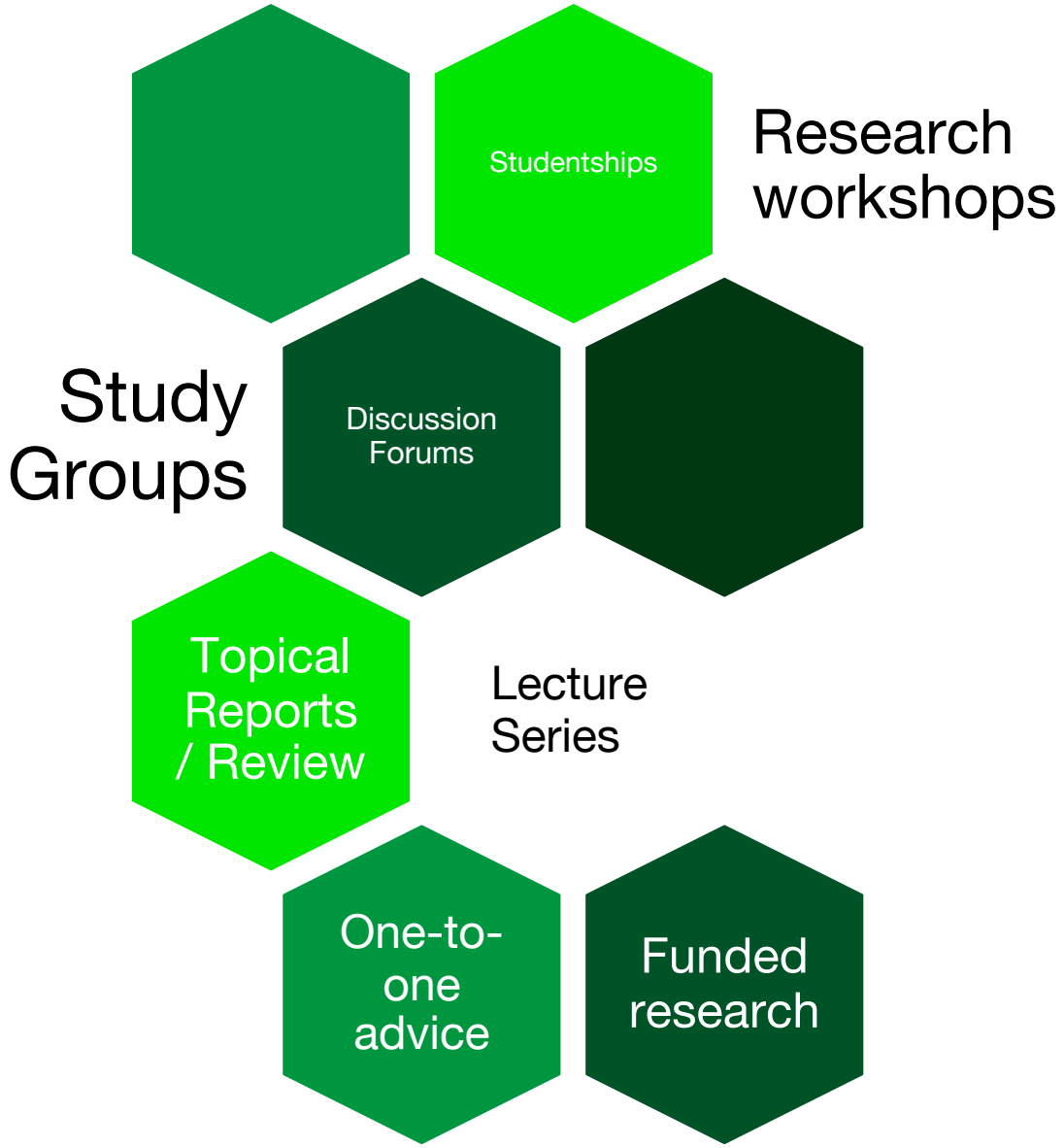
Why we did this

VKEMS was set up to continue constructive KE during the lockdown for **economic and societal benefit,** and to set up **valuable infrastructure for the future.** Closely aligned to **the Bond Review** recommendation of a **National Centre for Impactful Mathematics,** V-KEMS will provide an interface for government and industry to access KE with the UK Mathematical Sciences community during the current crisis and beyond.



Some of the organisations we have worked with

Innovate UK

Agri-Food Logistics. Covid19 Threat and Opportunities

UK FLUIDS NETWORK

Decontamination of Covid19 Infected Spaces

FareShare
fighting hunger, tackling food waste

Feeding Vulnerable People

Universities UK

Unlocking Higher Education Spaces

Department of Health & Social Care

Unlocking the Workforce

NHS

Covid19 Impact on Cardiovascular Waiting Lists

NetworkRail RSSB First

Risk of Covid19 Transmission in Rail

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The study group workshops that we've facilitated

Pilot Virtual Study Group	Apr 2020
Guiding Principles for Unlocking the Workforce - What Can Mathematics Tell Us?	Apr 2020
Unlocking Higher Education (University) Spaces	Jun 2020
Feeding Vulnerable people	Jun - Jul 2020
ESGI 162	Jul 2020
Agrifood Supply Chains	Sep 2020
How can Modelling Inform a Response to the Current COVID-19 Resurgence?	Oct 2020
Modelling Heterogeneous Systems	Dec 2020
Covid-19 Risk of Transmission on Trains	Jan 2021
Modelling Solutions to the impact of COVID-19 on Cardiovascular Waiting Lists	Feb 2021

numerous regular seminars, webinars, scoping meetings, ongoing discussions and follow-ups

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Case study

Unlocking higher education space post lockdown

The situation in June 2020 (at the time of the workshop)

- Universities and knowledge they create had been **vital in the fight against the COVID19 pandemic**.
- In addition, universities **support regional economic growth** through direct employment and the many services and outlets connected to them.
- However, **campuses largely closed, physical teaching suspended**
- UK Office National Statistics **(June 2020)** suggested about 1 in 1,600 people in England had Covid19, it was assumed all universities should expect to have some on-site infection even after re-opening
- Detailed data from **one University:**

Group	Count	Have been infected	Uninfected
Staff only	6,000	480	5,520
Students and staff	33,215	2,657	30,558

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A Multi-faceted problem - breakdown into three groups (rooms)

1. **Building level**

A. Flow in buildings

B. Loading and unloading

C. Small space management and scheduling

Focus only on this today

2. **Campus level**

A. Size, membership and leakage of student bubbles

B. Flow on campus

C. Difference between students / non-students / visitors

3. **Community level**

A. Public transport flow and bottlenecks

B. Freshers flu and community?

C. Employment – long range interactions

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We sub-divided into three separate problems:

A. How should 2 hours teaching per week be delivered temporally ?

B. How does surface cleaning strategy affect infection rates?

C. Is there capacity to give every student Present-in-Person time weekly?

Assumptions (and what do we mean by “a solution”)

Airborne transmission scenario results calculated with:

- One infectious person initially in the room.
- 2 hours in person teaching per week by same staff member.
- Social distancing at 2m (16 students) or 1m (28 or 44 students).
- **Model:** one staff member and 5 to 32 students in the space.
- **Primary activity:** lecture or seminar with a range of people talking.
- 2 hours in person teaching per week by same staff member.
- Smaller class size N reduces infection rate I, since I is proportional to N^2
- No other factors are accounted for e.g. reckless intent

Important lesson on ethics all output reports contain this caveat:

This report contains preliminary findings that have not been peer reviewed. The findings are intended to provoke further study and policy discussion and should not be treated as definitive scientific advice in response to the SARS-CoV-2 epidemic. Whilst we expect these principles to help others formulate coherent and consistent guidelines, time has prevented any quantitative study of their effectiveness. This could be undertaken, but would require real data and time to build more detailed simulation tools. Thus, we are not able to make specific recommendations from the principles.

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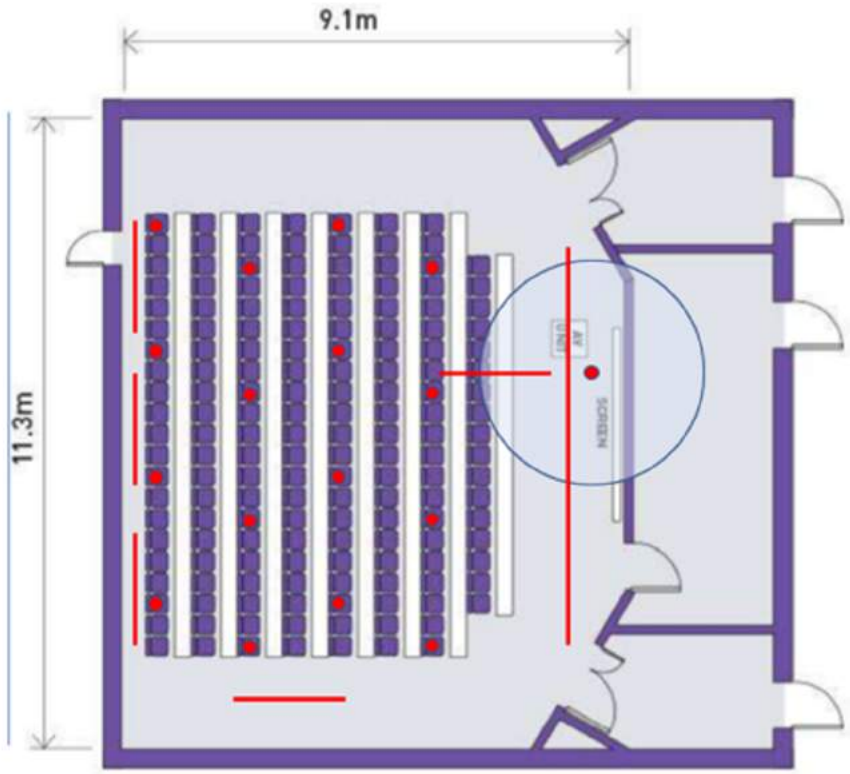
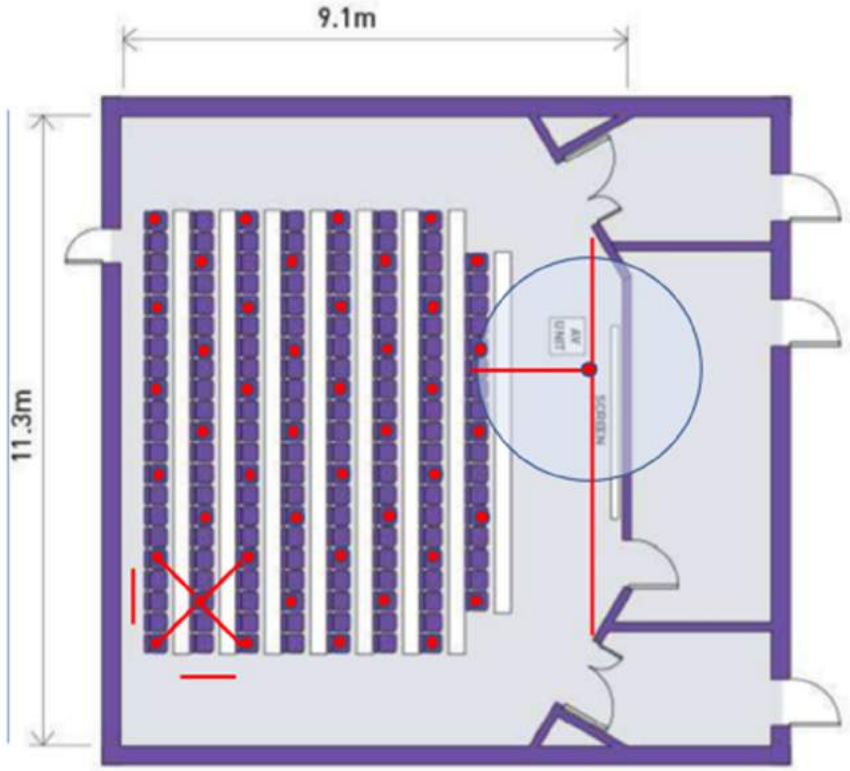
Boundary conditions - graphical considerations

- **164 seat lecture theatre fits 16 students (i.e. 10 %) at 2 m social distancing**
- **up to 44 students (27 %) at 1 m social distancing.**





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Assume infection due to droplets

Class size: $N = S + I$ S: Susceptible I: Infected

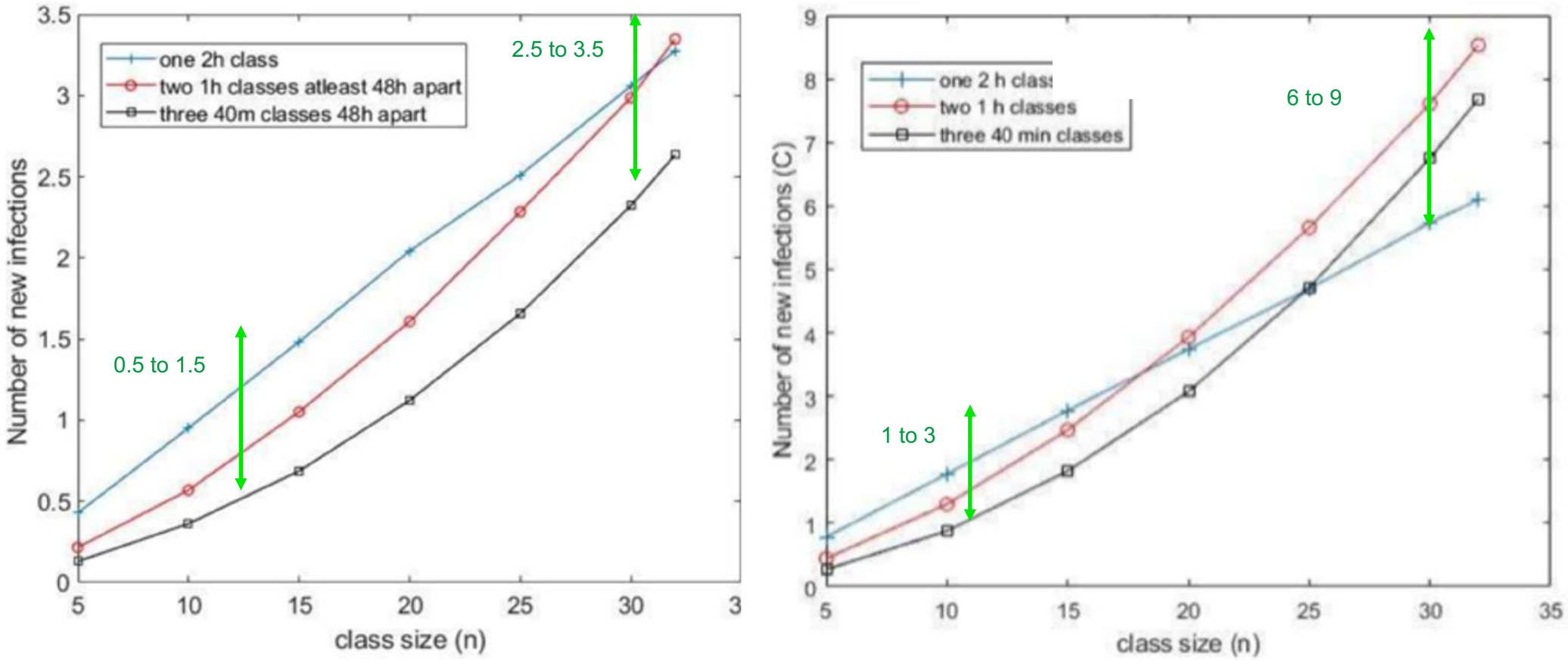
In time t the new number that get infected is given by the Gammaitoni-Nucci equation

$$C = S\left(1 - \exp\left(-\frac{pI\emptyset}{V}\left(\frac{Mt + \exp(-Mt) - 1}{M^2}\right)\right)\right)$$

Some data / assumptions

	Parameter	**Value**
V	Room volume	Approx. 300 m^3
M	Room ventilation	Approx. 4
$\emptyset$	Rate of projection of the infected droplets	10.5 – 320 (Depending on activity)
p	Pulmonary ventilation rate	N(0.48, 0.2) (Random variable)
t	Lecture time	In hours
I	Infections	Initially 1

Example results



(left) lecture levels of talking (low ø) and (right) active seminar levels of talking (higher ø)

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Summary of results

Options modelled:

a) One 2 hour class

b) Two 1 hour classes, 48 hours apart

c) Three 40m classes, 48h apart

- Best worst case choose **option a** - *assuming variable teaching activity & variable social distancing*.
- Best for low density, standard lecture levels of talking choose **option c -** *assuming 16 in room i.e. 2 m social distance (range 0.5 to 1.5 new cases per week)*
- Best for higher density, active seminar levels of talking choose **option a** - *assuming 32 in room i.e. 1 m social distance (range 6 to 9 new cases peer week)*

What happened next

- Report shared with many Universities across the UK (some senior managers actually attended the study group) also shared with UK government's scientific advisory group (**SAGE**) and its modelling subgroup (**SPI-M**) feeding into public policy.
- Two follow-on events as part of the **Isaac Newton Institute** Infectious Dynamics of Pandemics Programme.
- HE working group set up consisting of participants from several institutions and contains members of V-KEMS (including **Rebecca Hoyle** and **Chris Budd**) and SPI-M to look at many modelling issues regarding HE and COVID-19, its results have been presented to SAGE on several occasions.

Conclusion

- **VKEMS** is an example of a national-scale collaboration organised “on the fly” at the start of COVID19 lockdown by several agencies and academics interested in Knowledge Exchange in the Mathematical Sciences.
- Active and successful in bringing the full range of mathematical sciences to bear on short term challenges arising from COVID19 (economic, social and environmental) from government, industry, and third sector - **participation from almost 1,000 separate mathematical scientists (UK & international)**
- Led the way on how knowledge exchange can be delivered, indeed thrive, in a virtual world
- **Case study on Opening Higher Education Spaces:**
    - Ethics: we are providing mathematical principles not “Scientific Advice”
    - Rapid reports made available (see VKEMS website for examples from each study group)
    - Led to a sub-committee which reports into the UK Govt Scientific Advisory Group
- Provided a forum for mathematical scientists who want to make a difference during pandemic.

Thank you

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