Workshop Report for the interdisciplinary workshop on

"Mathematical Virology"

at the International Centre for Mathematical Sciences in Edinburgh,
6^{th} – 10^{th} August 2007
organised by Dr. Reidun Twarock (York) and Prof. Peter Stockley (Leeds)

1. Significant deviations from the original proposal

We were positively surprised by the overwhelming interest in our workshop by leading researchers in all three disciplines represented in this interdisciplinary meeting: Mathematics, Biophysics, and Biology. In response to that, we *increased the number of participants to 42*. As a consequence, the ICMS premises did not provide lecture space of sufficient size, and we had to *rent a lecture room at the University of Edinburgh*.

Owing to the unexpected number of high-profile participants, we *increased the number of speakers*. This was necessary also in view of the fact that the oversea participants had to subsidize their travel expenses via grants that required them to give an oral presentation. We therefore opted for 40 min talks including discussion, rather than the originally planned 45 min talks plus discussion, with a limited number of shorter talks for some of the research students as mapped out in the proposal.

We were originally not planning to seek funding from other sources, but in response to these developments we *attracted extra funding* from the IOP (Institute of Physics), the COB (Company of biologists) and various industrial sponsors. We welcome this opportunity to record our thanks to Beckman, BIAcore, Dionex & Horiba Jovin.

2. Short description of the meeting (<200)

This interdisciplinary workshop on "Mathematical Virology" has brought together high-profile researchers as well as young scientists and research students from the disciplines Mathematics, Biophysics and Biology, to discuss experimental and theoretical challenges at the forefront of virology. A collaboration of these disciplines is key for our understanding of the mechanisms underlying viral diseases. This workshop focused on important aspects of virus research such as the structure and physical properties of viruses, their formation, the structure and injection of the viral genomic material, and viral evolution. The workshop has shown how theoretical approaches, such as mathematical and biophysical techniques, can make a real impact on research in virology, and that also approaches from pure mathematics are very relevant in this context. As a result of this workshop, a number of new collaborations were formed within and across discipline boundaries, and new experimental and theoretical approaches were inspired. The meeting has intensified the interdisciplinary dialogue between the leading groups in that area, and has sparked crucial new insights that ultimately lead to new developments with impact on the greater public, for example, via anti-viral drug design or applications in gene therapy and bio-nanotechnology.

3. Comprehensive Report (about 1000)

The unique interdisciplinary atmosphere with an unusually pronounced willingness and openness to engage into discussions across discipline boundaries by representatives of all three disciplines - Mathematics, Biophysics and Biology - has clearly been one of the most remarkable highlights of this workshop. It is often very difficult to induce such a mixed community to engage into meaningful interdisciplinary discussions, and we are therefore very pleased to see, as confirmed also by the feed-back forms, that there is a general consensus that this interdisciplinary meeting really worked. Usually, conferences in this area of research are either predominantly theoretical or experimental in nature with little or no cross-talk between disciplines, and this workshop has therefore closed an important gap in the scientific landscape in this area of research. Indeed, as one of the participants said on the form: “It is the first truly interdisciplinary workshop in virology that I have attended.”

We were very fortunate that due to the unusually high density of high-profile participants from all disciplines involved, talks and discussions were generally of a very high standard. This again resonates with the feed-back forms that classify the overall academic value of the workshop throughout as extremely high. The composition of the workshop programme was also very well received by most participants, and we are pleased to see that the topics mentioned as key future research areas were all featured prominently in the workshop programme. Moreover, we are delighted that the workshop was also well received by the more junior researchers. One of them mentions explicitly that he/she considers the workshop as very worthwhile for their developing career, especially since senior researchers were very willing to have discussions with experts and newcomers alike.

Another highlight of the workshop has been the fact that techniques from pure mathematics, such as knot theory, group theory and topology, were featured prominently at the workshop and proved very relevant to the study of viruses. For example, knot theory is important for understanding the structural organisation of the viral genome within a virus, group theory is important for predicting virus structure and modelling vibrational modes, and topology plays a crucial role for the study of the RNA cage structure that have been observed in some virus families. Moreover, “hidden symmetries” were mentioned as one of the highlights on the feedback forms. This is in particular reassuring in view of recent EPSRC initiatives such as “Mathematics into Biology” where examples are sought for how pure mathematics can contribute in a meaningful way to our understanding of biology.

The involvement of the participants into the workshop was exceptional: The willingness of the participants to engage into dialogue and lively discussions across discipline boundaries was exemplary, and resulted in a very productive and stimulating atmosphere. The feed-back forms show that this has been perceived by all participants. A moderated free discussion session has also been very well-received, and has been mentioned as one of the highlights on the feed-back forms.

We are very pleased to see that participants were in general very happy with the size of the workshop. One participant mentions explicitly that the workshop had the right equilibrium between being large enough to feature a broad range of interests and expertise, whilst being small enough to give everyone the opportunity to meet and talk seriously with all other participants. We have received similar feedback in person from several other participants, so we are confident that this represents the point of view of the majority of the participants.

Given our experience with our previous workshop on Mathematical Virology in Oxford in 2004, it is not surprising that a significant number of new interdisciplinary collaborations have resulted from the meeting. The feed-back forms mention quite a few new collaborations and contacts that have been established in response to the workshop, and the response of the participants on the likelihood of these contacts resulting in new research is overwhelmingly positive.

Similarly, there is a strong consensus that the workshop has sparked new ideas for research. The programme has been described as “thought provoking” and “stimulating a deeper appreciation of the physical principles underlying viral structure and function”. It has been one of the main goals of the workshop to further the understanding of mechanisms in virology, because these are at the heart of new developments in anti-viral drug design and bio-nanotechnology, and we are therefore very pleased to see that also the participants feel that this goal has been achieved by the workshop. Moreover, manifold synergies have been mentioned that arose from the cross-disciplinary interactions that have been

nurtured by this workshop: For example, participants mentioned that the workshop provided a unique opportunity for theoreticians to check their models against experimental insights, which “changed their understanding of the applicability of the models to certain groups of viruses”. Theoreticians moreover valued the insights provided by virologists, that they consider “beyond what one can get from the literature”. In return, experimentalists say that they got inspired to new experiments, and one even mentions in the feed-back forms that, in response to his/her interaction with mathematicians, “the meeting has made me look at experimental observations from a more general stand point”. Moreover, meaningful interactions within the same discipline also occurred and, for example, mathematicians with different approaches to the symmetry of viruses have inspired each other to develop new mathematical tools for the modeling of viruses, whilst different experimental groups have started collaborations on related experimental topics.

In order to capture the results of this workshop, we are publishing the proceedings of the workshop as a special issue of the journal Computational and Mathematical Methods in Medicine. Moreover, we have been approached by Imperial College Press to write a book on the state-of-the-art in the topics represented by this workshop. We are in the process of soliciting individual chapters from workshop participants on their areas of expertise, with a planned publication date in late 2008.

In summary, there is a strong consensus among the participants (and organizers) that the concept of this workshop has really worked for an interdisciplinary topic such as “Mathematical Virology”. This is also apparent from the demand for future workshops of the same type as reiterated both on the feedback forms and in individual emails sent to the organizers after the workshop. We feel encouraged to continue this workshop as a workshop series in the future, and expect that it will have, as this workshop has demonstrated, an important impact on the research landscape in the areas of Virology and Mathematical Biology.

Finally, we would like to thank Audrey Brown and Irene Moore for the excellent organization and very fruitful collaboration.