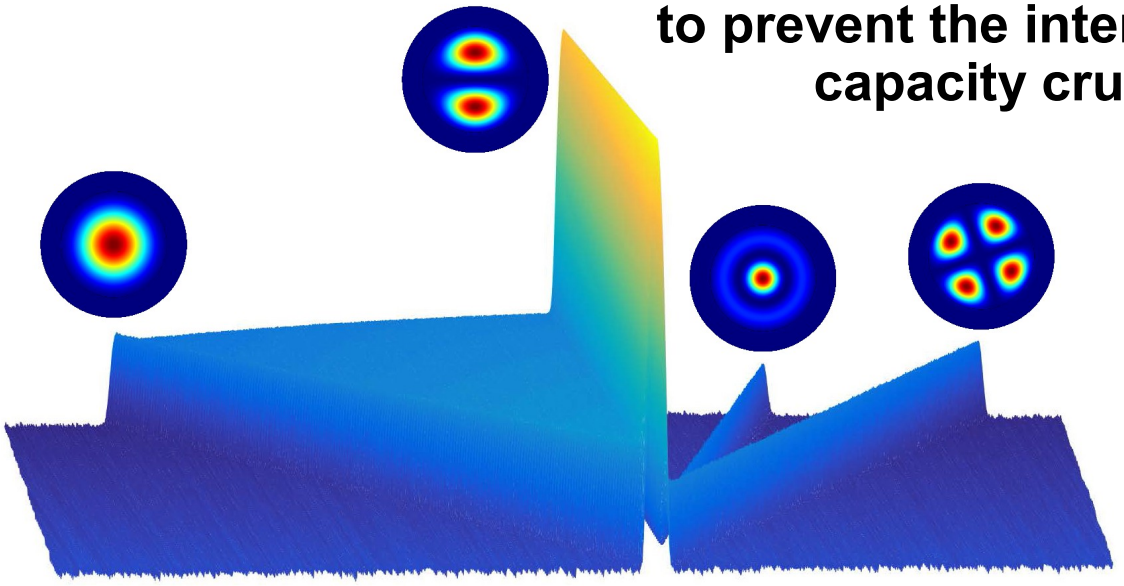
Take AIM

Smith institute
for industrial mathematics and system engineering

Differential equations to prevent the internet capacity crunch



TakeAIM Winner 2016:
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Whether we realise it or not, we use optical fibres everyday. Our emails, status updates, online videos, and websites are shuttled around the internet as light signals. The demand for internet capacity is expanding exponentially with the explosion of new capacity-hungry services e.g. cloud computing, social networking, and live high-definition video streaming, and also with more people becoming connected. While technologies have thus far kept up, this could change in this decade, when demand inevitably surpasses current fibre capacity limits — this means slower downloads for everyone. How can we overcome this 'capacity crunch'?

Recently, researchers searching for more capacity are studying a hitherto untapped channel: modes. Every optical fibre has a 'wave equation' which yields a discrete set of solutions called 'modes', each of which can theoretically support one communications channel, somewhat like how FM radio uses different electromagnetic frequency channels within the same atmospheric link. Although modes should ideally travel independently, in reality, they couple (mix) with one another due to various fibre imperfections, leading to undesirable channel interference. Previous fibres were thus deliberately engineered to support only one mode (i.e. 'singlemode').

My research aims to develop a model to study the mode coupling behaviour in new 'multimode' fibres. It involves using a powerful mathematical tool, namely coupled partial differential equations, to simulate the optical phenomena at play. With this, we can improve fabrication processes or discover better ways to robustly communicate using multiple mode-channels despite coupling, and hopefully increase capacity to ultimately preserve internet growth for future generations.

The Smith Institute, enabled by the generous sponsorship of our leading corporate partners, ran the TakeAIM competition in 2016 to make visible the crucial role that mathematics will increasingly play in all aspects of our lives. The competition was open to undergraduate and postgraduate students working in the mathematical sciences. The authors of the two best entries each received £1,250 of Apple vouchers as their prize, with Amazon vouchers being awarded to two runners-up.