

Rich and Nonlinear Tomography - a multidisciplinary approach

Tomographic imaging provides the ability to image properties in the interior of an object from measurements taken on its surface or in the far field. It is vital in medicine, manufacturing, geophysics, advanced material and security, to mention only few of its applications. Sensor technology is increasingly extending not only in the number of detector elements and the speed of acquisition but also by adding capability to resolve frequency, energy, polarisation state, transient response, resulting not only in higher data rates but also in richer data. Even though this holds the promise of imaging vector or tensor properties, the highly coupled and often non-linear nature of the underlying inverse problem means that new mathematical and computational methods are needed. Our programme Rich and Nonlinear Tomography - a multidisciplinary approach, was both ambitious and timely. We aimed to bring together not just those specializing in the mathematical disciplines analysis and geometry; numerical analysis; optimisation; and Bayesian statistics, but we also aimed to include specialists in the measurement science engineering and applications.

In the first week of the programme we saw a specialist in radar imaging, sitting with one in neutron tomography making a dictionary to translate the terminology they used for the mathematical objects involved in their reconstruction problems. This early sign of success was sustained throughout the programme. We not only collaborated mathematician with scientist/engineer, we also facilitated collaboration on seemingly different areas through common mathematics.

In our first workshop we took a risk of combining Radar, Astronomy and Geophysics. Well developed areas of applied inverse problems that rarely communicate. This paid off as lasting new collaborations were formed, and new mathematical problems formulated.

Our Open For business event was unusual. We wanted to encourage interaction between engineers who work on radar imaging including military applications with inverse problems. Radar people are constrained by both commercial and security considerations and are used to meet at NATO meetings. We did not want to restrict the international open and collaborative nature of the INI so we ran a joint NATO Newton Gateway meeting at the ICMS. A key aspect of a successful interdisciplinary meeting between two communities is that the right people come to an unfamiliar meeting and this worked very well. Indeed industry radar experts enthusiastically shared and helped mathematically formulate key current challenges.

The programme as a whole was characterised by visitors long and short working on a full range of problems spanning our anticipated mathematical and application. Participants were very positive about the experience, and there was a feeling that Rich Tomography was more than a buzz but a widely unifying theme that now had momentum and depth.