Draft programme

All lectures are scheduled for one hour.

Thursday 10 September

10:00–10:30	Coffee and registration
10:30–11:30	Tim Adamo – *Black holes in twistor space*
11:30–12:00	Coffee break
12:00–13:00	Bernardo Araneda – *A new landscape of gravitational instantons*
13:00–14:30	Lunch
14:30–15:30	Maciej Dunajski – *A twistor approach to toric gravitational instantons*
15:30–16:00	Tea break
16:00–17:00	Roger Penrose – *Bi-twistor theory, for general curved space-times*
17:30–18:15	Drinks reception
18:15–19:45	Dinner
20.00–	Film (Heidi Morstang) – *A Singular Imagination - Conversations with Sir Roger Penrose*

Friday 11 September

10:00–11:00	Roland Bittleston – *Twistorial Anomalies*
11:00–11:30	Coffee break
11:30–12:30	Atul Sharma – *The Giants of Twistor Theory*
12:30–14:00	Lunch
14:00–15:00	Mike Eastwood — *Killing 2-tensors*
15:00–15:20	Break
15:20–16:20	Rod Gover — *Using tractors and to solve Killing type equations and yield (super)integrable systems*
16:20–17:00	Break
17:00–18:00	Claude LeBrun — *Desingularizations of Conformally Kaehler, Einstein Orbifolds*
18:45–	Pre-dinner drinks for dinner at 19.30

Saturday 12 September

10:00–11:00	Mariana Carrillo Gonzalez — *Double copy in (A)dS from twistor space*
11:00–11:30	Coffee break
11:30–12:30	David Skinner — *Title TBA*
12:30–14:00	Lunch
14:00–15:00	George Sparling — *Reflecting on twistor theory from the past to the future*

Titles and abstracts

Tim Adamo (Edinburgh):
Title: *Black holes in twistor space*
Abstract: Abstract: Fifty years ago, Penrose's non-linear graviton theorem taught us that vacuum self-dual (or hyperkahler) metrics arise from analytic data in twistor space. Since then it has remained a persistent challenge to get away from the self-dual sector at the fully non-linear and non-perturbative level, something which has become known as 'the googly problem.' In this talk, I will present a resolution of the googly problem for one particular, but physically interesting, solution of the Einstein equations: the Schwarzschild metric. The construction exploits the rich interplay between algebraically special metrics of type D and Kahler geometry, building on many ideas of Penrose and his intellectual descendants over the years.

Bernardo Araneda (Edinburgh):
Title: *A new landscape of gravitational instantons*
Abstract: Recent developments have shown that the space of (non-self-dual) gravitational instantons is vastly richer than previously believed, overturning longstanding conjectures related to black holes and uncovering a virtually unknown landscape. In this talk, I will present a new framework that combines complex and projective geometry to produce large new families of solutions, some of which turn out to have an unexpected connection with twistor theory.

Roland Bittleston (Perimeter/Harvard):
Title: *Twistorial Anomalies*
Abstract: In recent years it has become clear that local symmetries of field theories on twistor space are generically anomalous at the quantum level. Among these twistorial anomalies are avatars of the familiar four-dimensional chiral and conformal anomalies, while others encode global obstructions to the integrability of self-dual gauge theory and gravity. In this talk I will introduce these twistorial anomalies and review some of their applications, including index-theoretic derivations of the one-loop QCD β-function and the a- and c-anomalies, as well as the computation of scattering amplitudes on both flat space and non-trivial backgrounds. This talk draws on several collaborations with Kevin Costello, Atul Sharma and David Skinner.

Mariana Carillo Gonzalez (Southampton):
Title: *Double copy in (A)dS from twistor space*
Abstract: The double copy provides a well-established relation between gauge-theory and gravitational data in flat spacetime. Extending this relation to curved backgrounds introduces several conceptual and technical challenges, including identifying the framework in which the double-copy structure is most naturally realized. I will show that twistor space provides such a framework in (A)dS. In particular, I will discuss how classical double copies for black-hole and wave solutions, as well as double-copy structures in boundary correlators, admit a natural and unified realization in twistor space.

Maciej Dunajski (Cambridge):
Title: A twistor approach to toric gravitational instantons.
Abstract: I shall discuss some ongoing work with Lionel Mason and Paul Tod (which builds on an earlier work on Woodhouse and Mason, and an even earlier work of Ward) on a twistor construction of holomorphic vector bundles for ALE and ALF gravitational instantons with toric symmetry.

Mike Eastwood (Adelaide):
Title: *Killing 2-tensors*
Abstract: Very much akin to solving the twistor equation via local twistor transport, it is well known that Killing fields can be realised as the parallel sections of a suitable vector bundle with connection. The same is true for Killing 2-tensors but what is not so clear is how these bundles may be aligned so as to accommodate the natural quadratic map from Killing fields to Killing 2-tensors. I shall explain how this can be done and some of its consequences. This is joint work with Thomas Leistner.

Rod Gover (Auckland):
Title: *Using tractors and to solve Killing type equations and yield (super)integrable systems.*
Abstract: The Killing equation and its generalisations for Killing tensors are important for the study of symmetry, structure deformations, and for yielding integrable solutions of Hamiliton-Jacobi and Laplacian equations. These Killing equations arise in some differential complexes known as BGG complexes. Understanding this is one of the key steps to a new approach to constructing collections of solutions to these equations that we outline in this talk. The interaction of the prolonged system with scale is managed by tractors and yields the desired solutions. These then provide first integrals for

equations such as the geodesic equation, other Hamiliton-Jacobi equations and for Schrodinger operators equations. The overall story demonstrates a beautiful interaction of mechanics, geometry, and algebra.

This is joint work with Simon Goodwin, Thomas Leistner, and Jonathan Kress

Claude LeBrun (Stonybrook):
Title: *Desingularizations of Conformally Kaehler, Einstein Orbifolds*
Abstract: In this talk, I will discuss the following result, which was proved in joint work with Tristan Ozuch.

Suppose we are given a sequence of smooth compact oriented Einstein 4-manifolds with fixed positive Einstein constant that Gromov-Hausdorff converges to a 4-dimensional Einstein orbifold. Suppose, moreover, that the limit metric is Hermitian with respect to some integrable complex structure on the limit orbifold, and that this orbifold has at least one singular point. Finally, suppose that every gravitational instanton that bubbles off from the sequence is anti-self-dual. Then, far out in the sequence, all the given Einstein manifolds are actually Kaehler-Einstein. As a consequence, the limit orbifold is also Kaehler-Einstein, and must in fact be one of the orbifold limits classified by Odaka, Spotti, and Sun.

Roger Penrose (Oxford):
Title: *Bi-twistor theory, for general curved space-times.*
Abstract: Whereas in a general conformally flat space-time the conformally invariant twistor equation can be used (at least locally) to provide a definition of a twistor, this equation fails to have non-zero solutions in a general conformally cured space-time M. However, the weak twistor equation (acting on a single-unprimed-indexed quantity omega, where all remaining unprimed indices are contracted with omegas) yields a corresponding single primed-indexed quantity $\eta_{A'}$. When the corresponding (complex conjugate) process applied to $\eta_{A'}$ leads back to ω, the pair defines a general null geodesic in M.

Atul Sharma (Harvard):
Title:*The Giants of Twistor Theory*
Abstract: The finiteness of the entropy of a black hole suggests that quantum gravity in a bounded region contains a finite number of degrees of freedom. We study a toy model of this statement by applying the holographic principle to twistor string theory and obtaining a twistorial stringy exclusion principle.

David Skinner (Cambridge):
Title:
Abstract:

George Sparling (Pittsburgh):
Title: *Reflecting on twistor theory from the past to the future*
Abstract: I will discuss the basics of twistor theory as I understand them, emphasizing that, a priori, twistor theory is a quantum theory and in that light, I will present recent work that aims to mesh quantum theory, twistor geometry and spacetime, joint work of my colleague Jonathan Holland and myself.