RANDOM WALKS
Match maker
Phys. Rev. E (in the press); preprint at http://arxiv.org/abs/1507.03886

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The unfolding of a football match captures the attention like few other spectacles. But are we riding the edges of our seats over a story determined purely by chance? Dilan Patrick Kiley and colleagues sought to find out by analysing the statistics of score lines drawn from matches played in the Australian Football League.

Kiley *et al.* took the scoring statistics from 1,310 matches, spanning seven seasons, and computed the score differential between teams at each second of play. The resulting time series was dubbed a 'game story' and mined for statistical motifs that might help us better understand the dynamics of competitive sport.

The team conducted an analysis of conditional probabilities for winning as a function of lead size, and compared their game stories with random walks, finding them to be more diffusive than simple random walks. A biased random-walk model based on skill differential was deemed the most appropriate null model, but the real game statistics featured far more blowout and comeback motifs — the events that raise our collective pulse — than the random walk. *AK*

BLACK HOLES
Precision scales
Astrophys. J. Lett. **822,** L28 (2016)

Ever wonder how astronomers measure the mass of a black hole? One way is to map the speed of the rotating disk of gas around it. The Hubble Space Telescope, for example, has mapped many hot disks of ionized gas, but the turbulent motion leads to large measurement uncertainty. Cold molecular gases would be more stable, but they are not visible at optical wavelengths. Fortunately, this situation is ideal for radio telescopes; Aaron Barth *et al.* have used the Atacama Large Millimeter/submillimeter Array (ALMA) of 66 telescopes in Chile to observe NGC 1332 — a massive elliptical galaxy 73 light years away. They found the central supermassive black hole to be 664 million solar masses, with error bars at the 10% level.

The rotating disk is 800 light years across, but only within the sphere of influence of the black hole (80 light years) is the gravitational force of the black hole dominant. ALMA can see details down to 16 light years, and was able to determine a rotation speed of 500 km s^{-1}. This kind of resolution will help measure other black hole masses with unprecedented precision. *MC*

DIRAC SEMIMETALS
Lead a double life
Phys. Rev. Lett. **116,** 186402 (2016)

The pseudo-relativistic physics that gives 2D graphene its fascinating properties can also be found in 3D materials known as Dirac semimetals. The common feature of such systems is the existence of Dirac points in momentum space, at which the conduction and valence bands meet. Here, the electronic band dispersion is linear, and so the electrons behave like relativistic particles. Benjamin Wieder and colleagues have now predicted a new class of Dirac semimetal that would feature double Dirac points.

In bulk materials, Dirac points are a consequence of symmetry and topology in the electronic structure. The Dirac points of Dirac semimetals are fourfold degenerate and, in certain cases, strain can be used to tune the system to behave either as a trivial or topological insulator. Using tight-binding models, Wieder *et al.* showed that seven of the 230 space groups can host a double Dirac point that would be eightfold degenerate. Such systems could be tuned into either a trivial or a topological insulator phase by applying strain along two different directions, providing a unique platform for topological band structure engineering. *LF*

POLYMER PHYSICS
Loopy glasses
Proc. Natl Acad. Sci. USA **113,** 5195–5200 (2016)

The dynamics of melts — or concentrated solutions of linear polymers — is reasonably well understood in terms of 'reptation': snake-like motion of the polymer chains through the spaghetti structure. But systems of ring polymers, lacking free ends, behave completely differently. By means of computer simulations, Davide Michieletto and Matthew Turner have now uncovered a fascinating property of ring polymers: their ability to form a glass, not via temperature or density changes, but from topological constraints alone.

Michieletto and Turner modelled ring polymers as coils of beads numbering up to 2,048, and first made the observation that a system of rings extensively interpenetrates. The authors then investigated what happens when — starting from an equilibrium configuration — a randomly chosen fraction of the polymers is pinned. Spatially and temporarily freezing certain rings makes the others subject to inter-coil, non-crossability constraints. Remarkably, the ensuing inter-ring 'threadings' can result in kinetically arrested states — in other words, glasses. The more beads on each coil, the smaller the fraction of pinned rings needed to create a glassy state — suggesting that a ring-polymer glass could be realized by optically trapping just a few polymers. *BV*

SINGLE-MOLECULE MAGNETS
Spinning around
Nature Commun. **7,** 11443 (2016)

A hundred years ago, Albert Einstein and Wander Johannes de Haas tried to confirm the theory of molecular currents proposed by André-Marie Ampère to explain magnetism. They found that an iron cylinder suspended by a string inside a coil started to rotate when an electric current was turned on. This observation relating spin and mechanical angular momentum became known as the Einstein–de Haas effect. But if the iron cylinder in the original experiment were replaced with a single spin, would the total angular momentum still be conserved?

Marc Ganzhorn and colleagues studied such a quantum version of the Einstein–de Haas effect using a single-molecule magnet attached to a carbon nanotube mechanical nanoresonator. They found that for individual spins, the total angular momentum and energy were indeed conserved, and this manifested itself as a complete suppression of the quantum tunnelling of magnetization. The suppression was independent of external noise factors, suggesting that it could become useful in molecular spintronics. *IG*

Written by May Chiao, Luke Fleet, Iulia Georgescu, Abigail Klopper and Bart Verberck.

Correction

In the Research Highlight 'Dirac semimetals: Lead a double life' (*Nature Physics* **12,** 528; 2016), the final sentence was incorrect and should have stated that the described system could be tuned into either a trivial or a topological insulator phase. This has been corrected in the online versions 9 June 2016.