

High-Resolution Spectrum of an Exoplanet

Unlike most of the extrasolar planets we know about, the four planets around the star HR 8799 were detected directly. **Konopacky et al.** (p. 1398, published online 14 March; see the Perspective by **Marley**) obtained a high-resolution spectrum of one of the planets that reveals both water and carbon monoxide but not methane in the planet's atmosphere. The atmospheric carbon-to-oxygen ratio, which traces the process of planet formation, is greater than that of the host star, providing clues to how the planets formed.

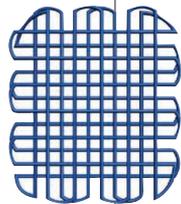
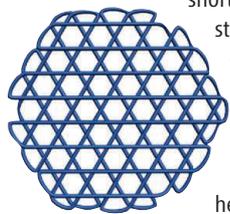
Photonic Spin Hall Effect

When charged carriers move in a magnetic field, they are deflected—an effect known as the Hall effect. Electrons possess charge and spin, a property related to magnetism. The symmetry of electromagnetism then allows for a spin Hall effect whereby the spin is deflected by an electric field. In optics, photons, too, have electric and magnetic components and should thus also exhibit a corresponding photonic spin Hall effect. Using designer metamaterial surfaces, **Yin et al.** (p. 1405) show that the spin-orbit coupling for photons can be amplified, giving rise to an observable photonic spin Hall effect.

Rewiring DNA Origami

Complex DNA nanostructures can be formed from a long scaffold strand of DNA by binding many shorter “staple”

strands. In these DNA origami structures, the path of the scaffold has been restricted by a double-crossover motif to form parallel helices. **Han et al.** (p. 1412) now describe a more flexible approach based on a “gridiron unit” in which four four-arm junctions link together to form a two-layer square frame. A variety of two- and three-dimensional structures were created, including highly curved structures, such as a sphere and a screw.



Dissecting TLR8 Interactions

Toll-like receptors (TLRs) activate the innate immune system in response to invading pathogens. TLR7 and TLR8 recognize single-stranded RNA from viruses and also contribute to the pathogenesis of autoimmune diseases. **Tanji et al.** (p. 1426) now report the crystal structure of the unliganded TLR8 ectodomain and the TLR8 ectodomain bound to three different small-molecule agonists. Ligand binding to preformed TLR8 dimers induced conformational changes that brought the C-terminal domains closer together, presumably initiating downstream signaling.

Making the Cut

Dynamin is the prototypical member of a large family of structurally related guanosine triphosphatases involved in membrane fission and fusion. A variety of models have been suggested to explain how dynamin works. **Shnyrova et al.** (p. 1433; see the Perspective by **Holz**) reconstituted dynamin-mediated membrane scission on lipid nanotubes and suggest a molecular model

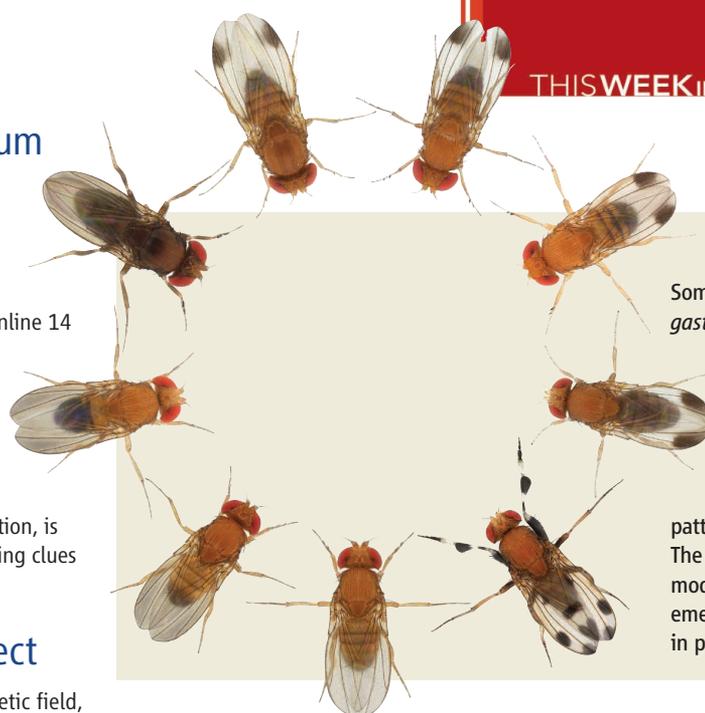
for dynamin activity that takes into consideration all known aspects of dynamin function.

Interfering with Interferons

Infections with *Mycobacteria*, including *Mycobacterium leprae* or *M. tuberculosis*, vary substantially in their clinical presentation. For instance, in some cases of *M. leprae*, the infection is self-healing with very few lesions. In contrast, some people experience the disseminated form, where skin lesions abound and bacteria are abundant. In patients infected with *M. leprae*, **Teles et al.** (p. 1448, published online 28 February) found that the disseminated disease associates with a type I interferon gene signature, whereas the self-healing form associates with a type II interferon gene signature. In cultured cells, type I interferon and its downstream signaling cascade inhibited the antimicrobial response induced by type II interferons, providing a potential explanation for why robust disease rather than protection is seen in some cases of infection.

Ear, Ear

Development of the middle ear has been the subject of competing hypotheses. **Thompson and Tucker** (p. 1453; see the Perspective by **Fekete and Noden**) used transgenic mice to follow the cell types that form the middle ear. During development of the middle ear, a balloon of endoderm expands that bursts, allowing entry of mesenchymal neural crest cells. As the mesenchyme withdraws, a cavity is formed, partly lined with remnants of the endodermal balloon. The mature middle ear in mouse is thus lined partly by endoderm, with its rich ciliation typical of mucosal epithelia, and in part by neural crest cells, which lack cilia.



<< Seeing Spots

Some flies in the *Drosophila melanogaster* lineage exhibit wing spots, which vary among species. Examining the underlying genetics of spot determination, **Arnoult et al.** (p. 1423) provide evidence for a two-step scenario for the origin and diversification of patterning novelty in these fly wings. The findings suggest that the two-step model may generally apply to the emergence and diversification of traits in plants and animals.

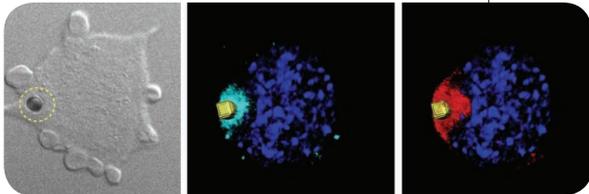
Additional summaries

Mind the Vacancies

Varying the carrier density of solid-state systems to manipulate their electrical properties usually involves chemical doping, which can lead to disorder. Recently, ionic liquids have been used to form an electronic double layer on the surface of a material, tuning its carrier density by the application of an electric field. **Jeong et al.** (p. 1402) used liquid gating on VO₂, which undergoes a metal-insulator transition close to room temperature. The liquid gating suppressed the transition to lower and lower temperatures; however, the material remained in the metallic state, even when the gating fluid was washed off. It appears that, instead of a simple electrostatic effect, the properties of VO₂ are modulated by the introduction of oxygen vacancies, an electrochemical consequence of high electric fields. The results imply that careful interpretation of liquid gating experiments in condensed matter physics is needed.

Three Tales of Wnt Signaling

The Wnt signaling pathway has important roles in regulating many biological processes during development and is also implicated in the behavior of some cancer cells (see the Perspective by **Berndt and Moon**). **Cruciat et al.** (p. 1436, pub-



lished online 14 February) describe the mechanism of action of a protein found in a screen for proteins that influence Wnt signaling. DDX3, a DEAD-box RNA helicase, is required for proper Wnt signaling in *Xenopus* and *Caenorhabditis elegans*. It appears to act not through its action as an RNA helicase or through adenosine triphosphate binding, but rather by interacting with the

protein kinase, casein kinase 1, and promoting its activation. **Huang et al.** (p. 1441, published online 31 January) investigated the function of receptor-interacting protein kinase 4 (RIPK4), the product of a gene whose mutation causes severe developmental defects in mice and humans. Overexpression of the protein in cultured human cells activated transcription of genes regulated by the Wnt signaling pathway, and loss of RIPK4 function inhibited Wnt signaling in *Xenopus* embryos. At the molecular level, RIPK4 interacted with the Wnt co-receptor LRP6 and the Wnt signaling adaptor protein DVL2 and promoted phosphorylation of DVL2. **Habib et al.** (p. 1445) used Wnt-immobilized beads to understand how external cues direct asymmetrical stem cell divisions. Spatially restricted Wnt signals oriented the plane of mitotic division and lead to pluripotency gene expression in the Wnt-proximal daughter cell while the more distal daughter cell acquired hallmarks of differentiation. Thus, asymmetric gene expression patterns can arise as a consequence of orientation by a short-range signal.

Walking on Sand

Studies of objects moving through air or water have provided detailed models for designing objects with better flow dynamics. Examples include aircraft fins and wings, robots used as underwater probes, and even swimsuits to enhance swimmers' competitiveness. Much less is known about the mechanics of moving objects on or in materials that themselves have non-uniform dynamics. For example, when walking on a granular medium like sand, the moving leg and foot may penetrate to varying depths with small changes in material properties. **Li et al.** (p. 1408; see the Perspective by **Hunt**) study this system and develop a model for predicting the motion of legged bodies on granular media for a range of leg shapes and motion speeds. Factors that complicate the motion include leg shape and size and movement direction, as well as the size shape, and uniformity of the granular material.

Working Together

The variability of atmospheric carbon dioxide concentrations over glacial cycles, which are central aspects of the climate cycle, was documented decades ago. However, it has been difficult to identify which mechanisms have driven CO₂ variability. Attention has focused on the Southern Ocean, because of its unique combination of hydrology and biology, although it has not been clear how the different behaviors of its Antarctic and Subantarctic zones might be reconciled with the observations of atmospheric CO₂ change. **Jaccard et al.** (p. 1419) present a record of productivity from the Atlantic Antarctic Zone that extends back in time far enough to cover the last 10 glacial cycles. The findings show how the combination of effects in the Antarctic and Subantarctic zones can explain most of the atmospheric CO₂ record over the past million years.

Diatom Fall

2012 saw the greatest Arctic ice minimum ever recorded. This allowed unprecedented access for research vessels deep into the Arctic Ocean to make high-latitude observations of ice melt and associated phenomena. From the RV Polarstern between 84° to 89° North, **Boetius et al.** (p. 1430, published online 14 February; see the cover) observed large-scale algal aggregates of the diatom *Melosira arctica* hanging beneath multiyear and seasonal ice across a wide range of latitudes. The strands of algae were readily dislodged and formed aggregates on the seabed up to 4400 meters below, where the algae are consumed by large mobile invertebrates, such as sea cucumbers and brittle stars. Although Nansen observed sub-ice algae in the Arctic 100 years ago, the extent of this bloom phenomenon was unknown. The dynamics of such blooms must impinge on global carbon budgets, but how the dynamics will change as ice melt becomes more extensive remains unclear.