that non-planar geometries associated with non-bonding orbitals – molecular orbitals that do not contribute to chemical bonding when filled by electrons – increase the separation of electrons and holes across the molecule, and thereby promote the decoupling of non-radiative transitions from high-frequency vibrations.

Ghosh *et al.* validated their design principles by preparing two new materials, both of which produced excitons with charge-transfer character, but only one of which had a molecular orbital with non-bonding character (Fig. 1). Sure enough, the combination of charge-transfer character and a non-bonding orbital resulted in strong decoupling of high-frequency vibrations, boosting the efficiency of the NIR emission quantum yield from 14% (for the compound that lacked separation) to 94%.

This is not the first attempt to bypass the energy-gap law to obtain efficient NIR emitters. Other researchers have found that OLED performance can be increased by fine-tuning the packing of emitter molecules in the solid state[4] and by reducing the frequency of vibrations of carbon–hydrogen bonds in the molecules by substituting the hydrogen atom with a deuterium[5]. The design principles of Ghosh and colleagues are based on observations of single molecules, but NIR emitters will be used in the solid state in future optoelectronics applications. It remains to be seen whether the principles will be affected by solid-state factors such as molecular packing or the structure of a device.

In the past decade, light-induced molecular vibrations have been reported to drive ultrafast reactions[6–9] in several molecular systems, and even to be coupled to excitons in biological complexes[10]. Identifying the nature of the induced vibrational modes and unveiling their role in the rapid electronic transitions has been challenging. In most of these studies, high-frequency modes are key. Ghosh *et al.* observed vibrations with frequencies of up to 1,700 cm^{-1} – close to the maximum frequencies that can be observed using state-of-the-art experimental techniques. The effects of higher-frequency vibrations in NIR emitters and other systems therefore currently cannot be observed. Furthermore, the specific molecular motions involved in the key vibrations remain elusive.

It will be interesting to see whether the design rules established by Ghosh and colleagues can be applied to make high-frequency vibrations enhance, rather than suppress, non-radiative transitions between excited states. This would enable the control and optimization of a range of light-induced ultrafast reactions (such as conical intersection crossings, singlet fission and electron transfers) through the design of appropriate molecules.

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The author declares no competing interests.

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Streamlined skull helps foxes take a nosedive

A snowy landscape offers few promises of food at first glance. However, red foxes (*Vulpes vulpes*) and Arctic foxes (*Vulpes lagopus*) can thrive in this harsh environment. These creatures can hear rodents moving beneath the surface of the snow, and use a predatory strategy of leaping into the air and diving head first (pictured) into snow to catch prey.

Slamming into snow at high speed might result in an injury unless the skull shape had evolved to minimize potential damage. As Yuk and colleagues report in *Proceedings of the National Academy of Sciences* (J. Yuk *et al. Proc. Natl Acad. Sci. USA* **121**, e2321179121; 2024), the skulls of animals that engage in this activity are well suited to provide protection.

The authors examined videos of this predatory behaviour in the wild, and used 3D-printed fox skulls to assess and model the forces that work on skulls dropped into fresh snow at high speed. Yuk *et al.* compared the skull shapes of the snow-diving foxes with those of other related species, and report that the sharp and elongated faces of the red and Arctic foxes help to reduce the force of impact experienced when plunging into snow.
Mary Abraham