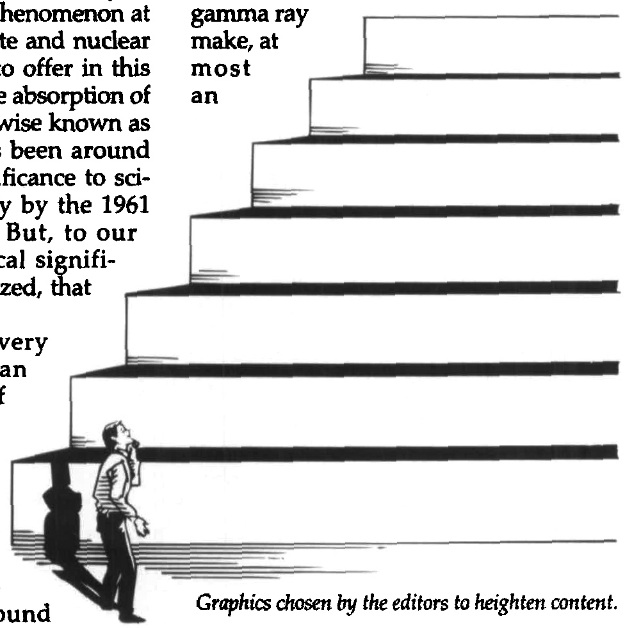
# Moving the Center of Mass

Have you ever been stymied by what seems to be a completely intractable obstacle? You can't go around it, you can't go through it, and it simply refuses to move despite your patience and persistence. Well, take heart! You may have been making more progress than you think. There is an elegant phenomenon at the intersection of solid-state and nuclear physics that has a lesson to offer in this regard. Recoilless resonance absorption of nuclear gamma rays, otherwise known as the Mössbauer Effect, has been around for over 40 years. Its significance to science was recognized early by the 1961 Nobel Prize in Physics. But, to our knowledge, its sociological significance has yet to be recognized, that is until now.

You see, there is this very excited nucleus inside an atom bound to the lattice of atoms in some macroscopic chunk of material. It feels compelled to fire off a gamma ray as one of its principal methods to unwind (and we presume to feel more comfortable with itself in its ground state). It doesn't care in what direction it fires and pretty much uses all $4\pi$ steradians, relying on serendipity to find useful targets where its radiation might illuminate. From the perspective of the nucleus, that gamma ray packs a wallop. This is not a delusion of grandeur but is based on a very real kick usually felt by the emitter as it recoils in an attempt to conserve momentum, a worthy goal indeed. The offending nucleus itself may even be knocked back off its perch. This is quite unsettling to the immediate neighborhood through which repercussions of the recoil propagate, generating a rather disorganized potpourri of vibrational modes that quickly degenerate into just so much very local heat. It's an event that goes largely unnoticed by the vast majority (roughly Avogadro's Number) of other nuclei in the chunk. Of course, conservation of momentum on the "chunk scale" will have its way, and the whole mass does itself recoil.[*] On average, however, thanks to all those steradians, the net movement over time is nulled and we needn't worry about the chunk flying off, or even inching its way off, a table in the lab.

As if this miniscule impact were not bad enough, just think of the disappointment when our nucleus, having expended all the energy it had available at the time, sees its gamma ray make, at most an equally localized and globally imperceptible impact on a neighboring chunk of similar material as it goes crashing into it. There, it can barely find a sympathetic nucleus willing to absorb it all at once. Target nuclei tend to be finicky about the precise energy of anything they are willing to assimilate. Therefore, the gamma ray fritters away its energy, disturbing as many individually nonessential constituent electrons as it needs to before it disappears altogether. The local hot spots frustrate the emitter and irritate the absorber. It is important to note, however, that whereas the emitter over time moves nowhere, the absorber receives its succession of insults all from the same direction and will be moved, albeit at a pico-tectonic pace.[†]



*Graphics chosen by the editors to heighten content.*

Perhaps this is little solace to those of you who have similarly assaulted massive bureaucracies only to see no result save the inevitable immune response to the attack of a foreign body. It is from common experiences of this kind that cliches as "whistling in the wind," "can't fight city hall," and "just a drop in the bucket," arise. The first lesson of the gamma ray exchange is that there is always movement, even though it is contemporaneously invisible. There will be a cumulative effect given a sufficient number of lifetimes (ours and the excited states'). And then, eventually, such cliches as "crack in the dike," "Achilles' heel," "fatal flaw," and "the straw that breaks the camel's back" get applied by those lucky enough to still be there to witness the immovable finally perceptibly move. We believe most of the aggravation until that occurs comes from the gross inefficiency of the low-RSE mechanisms employed.[‡]

It does no good to frustrate or irritate, so we contend that the "recoilless resonance" lesson of the Mössbauer Effect must be applied. If you and your colleagues bond well and lower the temperature of your arsenal, then your gamma rays stand a good chance of being recoillessly emitted. That is, no ancillary enervating phonons stir things up, and you are not personally required to sustain the initial recoil, but rather you get to share it with each and every one of your multitude of compatriots. As for the tight-knit absorber, it will find that your missile can easily find a perfect resonance with one of its members, generate no wasted heat, and impact the entire cadre of bureaucrats equally and in unison. They should appreciate that. They will realize that you and they must actually be twins separated at birth. Your ultimate victory should therefore be easier for them to accept.

May we point to the Magna Charta, Bastille Day, the civil rights movement, glass ceilings, the end of the Cold War and other unpopular protracted warmer wars, ultimate repatriation of the spoils of war, protecting the environment, a defacto Comprehensive Test Ban Treaty, peace in Northern Ireland, and doubling the budget for science and technology. Of course we are only talking about gamma rays here and past performance is no guarantee of future results.

E.N. Kaufmann

[*] This is no small effect! One 14.4 keV gamma-ray emitted by $^{57}Co$ from a 1 gram Fe chunk imparts a velocity to the chunk of $7.7 \times 10^{-21}$ cm/s or roughly 2.4 Ångstroms/century.

[†] Don't be concerned if the absorber is clamped to something, because then the whole building or planet will move and that only slows matters by a few more orders of magnitude.

[‡] Relative Sociological Effectiveness (RSE) is a measure of the capacity of specific ionizing radiation to produce a specific sociological effect expressed relative to a reference radiation such as one standard medical x-ray exposure. There is a theoretically unjustifiable empirical correlation with the ratio of the mass media absorption coefficient to the attempt frequency (decay rate) of the source.



https://doi.org/10.1557/S0883769400052210 Published online by Cambridge University Press