Due credit for Maxwell–Bloch equations

To the Editor — With 2015 being the United Nation's proclaimed International Year of Light and Light-based Technologies, I thought it would be apt to try to correct an anomaly in the naming of one of the most useful set of equations describing the interaction of light with matter — the so-called Maxwell–Bloch equations.

These coupled equations were not actually derived by Maxwell and Bloch, but instead can be traced back to a little cited (given its significance) publication by Tito Arecchi and Rodolfo Bonifacio[1], of Milan, Italy.

The equations describe an electromagnetic pulse interacting self-consistently with an ensemble of two-level atoms. The key advances were in the modelling of non-resonant interactions together with the mutual amplitude and phase evolutions of the electromagnetic wave and induced dipoles of the atomic ensemble. To do this succinctly required the invention of the slowly varying envelope approximation (SVEA) and its application to the wave.

The new information contained in the system of equations is essential in the modelling of now familiar effects, such as self-induced transparency, soliton propagation and photon echo, and the equations continue to be used widely to model and understand light–atom interactions. The term Maxwell–Bloch to describe the equations seems to have developed from a publication by S. L. McCall and E. L. Hahn[2] that describes the first experimental demonstration of self-induced transparency. The equations they derived to describe the effect are equivalent to those derived by Arecchi and Bonifacio[1].

McCall and Hahn, apparently unaware of the work by Arecchi and Bonifacio[1], used a 'reduced Maxwell equation' (in other words, SVEA was applied) to describe the electromagnetic field. They also cited similarities in describing atomic electric dipoles to the work and notation used by F. Bloch[3], which describes the interactions between nuclear magnetic moments and radio-frequency fields. Although not used directly in the work by McCall and Hahn[2], this Maxwell–Bloch terminology seems to have been adopted subsequently by other researchers.

So, in the interest of factual correctness and to give credit to where it is due, I propose the famous Maxwell–Bloch equations in future be assigned their correct provenance by calling them the Arecchi–Bonifacio (AB) equations. ❐

References

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The true status of solar cell technology

To the Editor — In their recent Commentary, Zimmermann *et al.*[1] highlight an issue that has been undermining the solar cell research community, particularly in relation to solution-processed organic and inorganic photovoltaics. Based on a study carried out on 375 publications in peer-reviewed journals, the authors identify (by comparing the short-circuit current density obtained through the current–voltage sweep versus quantum efficiency measurements) that a significant fraction (over 37%) of publications overestimated device performance.

It is now nearly a decade since Shrotriya and co-workers[2] described the accurate measurement procedures for characterizing organic photovoltaics. Their seminal paper highlighted the role played by factors such as spectral mismatch, the use of different grades of PEDOT:PSS and masking effects. These points have since been reinforced in subsequent publications[3,4]. Despite these guidelines, it is clear that the proposed methodology and protocols are not being adopted by a large fraction of the photovoltaic research community. The consequences of not being able to deliver on performance targets when devices are scaled or under prototyping result in expensive and drastic decisions later in the development cycle.

Although Zimmermann *et al.*[1] highlight a significant issue that requires corrective action for the field to remain credible, the question to be asked is what drives this selective reporting of results. Is it a lack of knowledge on proper device characterization? Is it the competition for funding? Is it the need to publish regularly in flagship journals? Or is it a general acceptance by the research community that this is the status quo? Whereas the first few reasons become less acceptable as a research field matures, the latter point is tied in with the peer-review process and consequently compounds the problem over time by allowing selected high-profile works to be given the benefit of the doubt.

Venturing beyond selective estimates of performance, it is also sobering to note how these reports are erroneously placed in the context of the research field as a whole. Consider the well-known photovoltaic efficiency chart created by the National Renewable Energy Laboratory (NREL) as a guideline. Although researchers place confidence in the chart, it needs to be questioned if the chart itself is the best source for the comparison of technologies. For example, can perovskites with 18% efficiency over a few square millimetres be compared to a crystalline silicon cell that can deliver 25% over ~144 cm^2? Moreover, the former have been indicated on the NREL chart as being unstabilized — they degrade spontaneously under exposure to light and air. This further begs the question as to whether the comparison often made with silicon photovoltaic technology is appropriate. Shouldn't a system that is considered to be a promising contender as a future photovoltaic technology display a sufficient level of stability for it to be incorporated into such an important performance chart? This is not to devalue in any way the potential contribution of perovskite technology in the future, once scaling and manufacturability of large-area devices has been achieved. But in the case of crystalline silicon, the technology took more than two decades to mature, and expecting