Foundations of Physics Letters, Vol. 12, No. 1, 1999

BRIEF COMMENT ON W. S. WARREN ET AL II: OPTICAL NMR AND THE $B^{(3)}$ FIELD.

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Received 3 September 1998

It is pointed out that the only possible artifact, free optical *NMR* (*ONMR*) shift of up to 0.1 *Hz* reported by Warren *et al.* [1] is the same precisely, 0.1 *Hz*, as that predicted by $B^{(3)}$ theory. However, the great majority of the data by Warren *et al.* are almost completely artifactual and cannot be used to discriminate between different *ONMR* mechanisms with any objectivity. Some references to $B^{(3)}$ theory and recent *ONMR* data uncited by Warren *et al.* are pointed out, data which show that the Warren group's failure to see very well known [2,3] polarization-dependent effects of irradiation in *NMR* is a major design failure, not one of theory.

Key words: $B^{(3)}$ theory, *ONMR* shifts, *ONMR* in quantum dots.

1. INTRODUCTION

Recently Warren *et al.* [1] reported possible laser-induced shifts in optical *NMR* (*ONMR*) of up to 0.1 *Hz* in very noisy data at extreme instrumental limits. They claim erroneously that these data prove the non-existence of the $B^{(3)}$ field and arbitrarily interpret what is probably an artifactual series of experiments through a mechanism by Harris and Tinoco [2], which produces shifts six orders of magnitude *smaller* than 0.1 *Hz*. In this Note these claims by Warren *et al.* are shown to be based on a lack of knowledge of both *ONMR*

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shift theory and of *ONMR* experiments in semiconductors [3]. The data do not support the claim that the $B^{(3)}$ field does not exist.

2. ONMR SHIFTS PREDICTED BY $B^{(3)}$ THEORY

It was argued in Ref. 4 (forwarded by mail to the Warren group some 18 months ago) that the $B^{(3)}$ theory produces the following equation for proton resonance in circularly polarized radiation of power density I and angular frequency ω:

$$\omega_{(\mathrm{resonance})} = 1.532 \times 10^{25} \frac{I}{\omega^2} \tag{1}$$

(Eq. (135) of Ref. 4, uncited by Warren *et al.* [1]). Under the conditions of Ref. 1 (three argon ion laser frequencies at 10 watts per square centimetre), the following *ONMR* shifts in hertz are obtained from Eq. (1): 0.12, 0.10, and 0.098 *Hz* at, respectively, 528.7, 488, and 476.5 *nm* in the visible [5].

The experimentally reported ***residual shift*** [1] is possibly up to 0.1 *Hz*, within 95% confidence limits, agreeing well with the $B^{(3)}$ field theoretical predictions.

These authors were apparently unable to see a dependence on circular polarization of the applied laser field. The latter type of dependence has been well known, however, for about a quarter century, and recently Brown *et al.* [3] have demonstrated very high sensitivity *ONMR* in single quantum dots using this mechanism. If preferred, it is not necessary to invoke $B^{(3)}$ theory to arrive at Eq. (1), it can be shown to be a straightforward result of the Schrödinger equation [5] for a spin-half particle, as discussed by Sakurai [6]. It has been shown recently to exist at all levels from classical to quantum electrodynamics [5], yet none of the work in Ref. 4, made available to Warren *et al.* by mail, is cited. In the original Ref. [4], Eq. (1) is derived from the Dirac equation, and a preprint was made available to the Warren group well before the publication of Ref. 1.

3. DISCUSSION

Warren *et al.* [1] claim that they cannot see a laser polarization dependence in their data, but at the same time appear to attempt to use a polarization-dependent off resonance theory of the *ONMR* chemical shift by Harris and Tinoco [2] which under their conditions produces a shift of about 10^{-7} *Hz* [2], six orders of magnitude smaller than the claimed shift of 0.1 *Hz* [1], as given by $B^{(3)}$ theory [4,5].

At 488 *nm*, the absorption of the laser by the sample is very small, as reported in the recent work by Warren *et al.* [7]. Therefore, the correct mechanism to use, surely, is that which is described by Harris and Tinoco as the ***single photon off-resonance population*** [2], by far the largest off-resonant mechanism in their calculation. Astonishingly, Warren *et al.* [1] use what appears to be a very strong resonant mechanism at 488 *nm* (which is very *far* from resonance) to produce a shift from the same Harris and Tinoco paper [2] of 270 *Hz* for protons and no less than 630 *Hz* for carbon thirteen. The claimed empirically measurable shift is in the range 0.57 to 1.06 *Hz*, again compatible with $\boldsymbol{B}^{(3)}$ theory [4,5] but wholly ***incompatible*** with a Harris and Tinoco theory of any kind. Yet this shift is attributed [1] to the Harris and Tinoco theory [2]!

It is not made clear why a mechanism which gives rise to a shift of 10^{-7} *Hz* according to Harris and Tinoco themselves [2] should give rise to a shift of more than 600 *Hz* as interpeted by Warren *et al.* [1] from the same paper [2]. The single photon off-resonance mechanism which surely should be used at 488 *nm*, where there is practically no absorption [1,7], has the ***same*** circular polarization and I/ω^2 dependence as $\boldsymbol{B}^{(3)}$ theory; in fact it is simply the chemical shift of the main resonance of $\boldsymbol{B}^{(3)}$ theory, but this fact is either overlooked by Warren *et al.* [1] or ignored.

The motivation behind this paper [1], which essentially appears to republish reference [7] using much the same data, is asserted to be doubts about the $\boldsymbol{B}^{(3)}$ theory. The present author is asserted to have to ***taken to calling*** the $\boldsymbol{B}^{(3)}$ field the Evans-Vigier field. Others accept this appellation by now. In their Ref. 7, reproduced as our reference [8] in this Note, Warren *et al.* cite critical papers [8] on $\boldsymbol{B}^{(3)}$ but cite ***none of the replies*** [9]. This is lamentable scholarship. No preprint of Ref. 1 was sent to the present author and no preprint was received from the Editors, despite the rather wild claims being made [1] that $\boldsymbol{B}^{(3)}$ does not exist. No citation of recent work on $\boldsymbol{B}^{(3)}$ appears in Ref. 1, despite the fact that the present author was the intellectual originator of the work by Warren *et al.* [7,10].

4. SUMMARY

The data in these series of experiments [1] are very noisy, but it can be stated objectively that the possible residual shift of up to 0.1 *Hz* observed empirically [1] is the same ***precisely*** (0.1 *Hz*) as that given by $\boldsymbol{B}^{(3)}$ theo ry [4,5] and utterly incompatible with the Harris and Tinoco mechanism [2] under far off-resonant conditions at 488 *nm*. The reason why no polarization dependence was observed [1] is not known, but in view of the well-known polarization-dependent data in Ref. 3, it is probably due to choosing completely unfavorable conditions under which to observe *ONMR*, in other words, a major design fault.

Acknowledgments. Approximately one hundred colleagues worldwide are thanked for ongoing e-mail discusions over the past three years in this subject area.

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