The Computation of Quantum Radar Cross Section for the Regular Five-Pointed Star

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Abstract. The quantum radar cross section is a kind of measure of the "quantum stealth performance" of the targets of interest. Obviously, it is extraordinary essential for the design and development of stealth weapon systems and platforms. In this paper, we have shown the simulation of quantum radar cross section (QRCS) and classical radar cross section (CRCS) for the regular five-pointed star. Based on quantum electrodynamics and interferometric considerations, we demonstrated the side-lobe quantum effect between QRCS and CRCS.

Keywords: Computation · Quantum radar cross section · Regular five-pointed star

1 Introduction

Quantum radar means is a speculative exploratory technology based on quantum dynamics which is the quantum version of classical dynamics. The QRCS could be a measure of the amount of returns from the given object illuminated with a handful of photons [1, 2]. Furthermore, due to the huge potentiality in term of different mechanism and counter-stealth, it has obtained extensive concern in the academy [3–14]. What's more, a prototype of quantum radar has been built in Austria in 2019 [15].

Nevertheless, this state-of-the-art technology is still stay in initial stage. Objectively, there are a lot of issues need to dispose, such as the target properties of all kinds of typical targets. Therefore, the computation of QRCS of the typical targets of interest, such as the regular five-pointed star, are worth demonstrating. In this work, we presented the interest curves of QRCS and the CRCS for the typical regular five-pointed star which is never published before.

2 Typical Scenario and Algorithm

Figure 1 shows the monostatic incident scenario of quantum radar that detects a regular five-pointed star.

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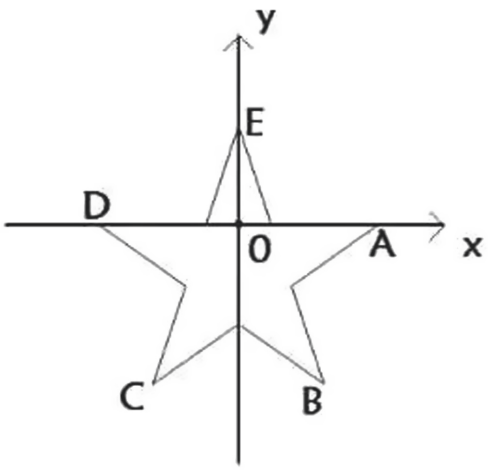
In general, if we assume we could ignore both the diffraction and absorption contribution, the simplified expression of QRCS for the case of single-photon incidence is given by [16–25]. More arguments specification may be seen in [16].

$$\sigma_Q = \frac{4\pi A_\perp(\theta_i, \Phi_i)\left|\sum_{n=1}^{N} e^{i(\vec{k_i} - \vec{k_s})\bullet\vec{x_n}}\right|^2}{\int_0^{2\pi}\int_0^{\pi/2}\left|\sum_{n=1}^{N} e^{i(\vec{k_i} - \vec{k_s})\bullet\vec{x_n}}\right|^2 \sin\theta_s d\theta_s d\Phi_s} \tag{1}$$

Based on this formula, we used the novel algorithm to calculate the QRCS the cases with single photon incidence by ourselves [26–34].



A (a+a*sin18° , 0)
B (acos36° ,- acos36° *cot18°+acos18°)
C (- acos36°,- acos36° *cot18°+acos18°)
D (- a- a*sin18°, 0)
E (0, acos18°)

Fig. 1. The geometry of the regular five-pointed star with a = 0.7265 m so that the distance between the barycenter and any convex vertex is 1 m.

3 Simulation Results and Discussion

From Fig. 2, from the green arrows, we can also observe the entirely different quantum effect of the sidelobe enhancement. Maybe we explain that means QRCS are larger than CRCS. Please note that the curves of CRCS are from the typical physical optics approximate method from FEKO software [35] (Fig. 3).

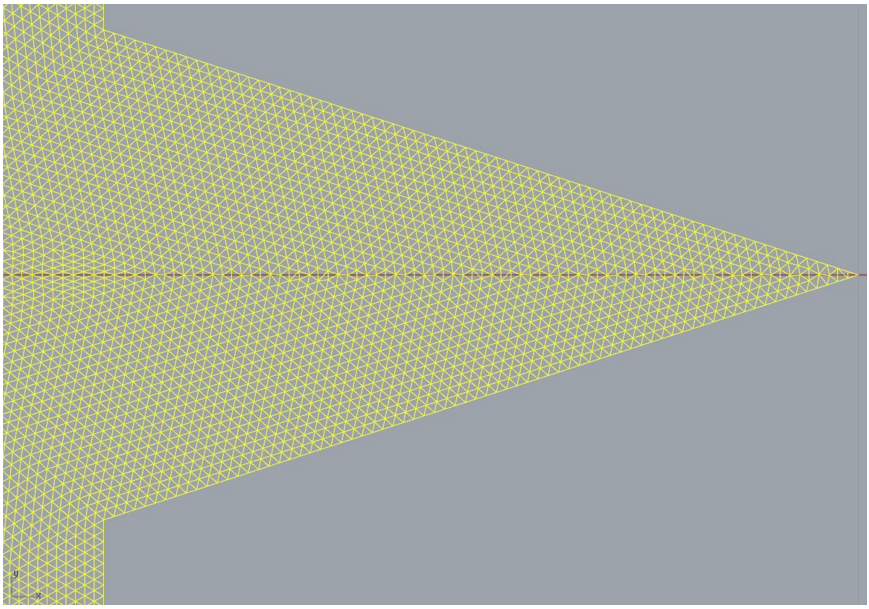


Fig. 2. Mesh of a regular five-pointed star.

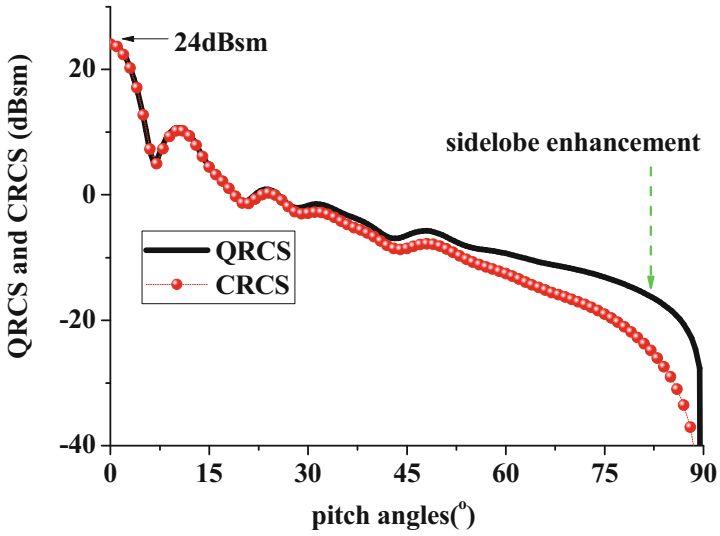


Fig. 3. Similarities and differences of the QRCS (black solid) and CRCS (red balls) curves for the regular five-pointed star with the single photon. (Color figure online)

According to the analytical expression of peak value in QRCS curve for the 2D plate in [1], $\sigma_{QMax\_rec} = 4\pi A^2/\lambda^2$, A denotes the area of the regular five-pointed star, the peaks at $\theta = 0°$ must be about 24 dBsm that QRCS values precisely are. They have been verified the precision of the technique in part. Then, for the regular five-pointed star, the side-lobe quantum effect from each side face may be superposed and almost reach the great difference in some angular range, such as 70°–90° nearby.

4 Conclusion

In this paper, a new calculated curve of QRCS for the regular five-pointed star was demonstrated. We also observed the similar side-lobe quantum effect in the comparison between QRCS and CRCS. More delicate work on the case of verifiable experiment is left for the recent future study.

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