Quantum Solar Energy

Aman Chawla

September 19, 2024

Abstract

In this note the authors propose an extended version of quantum illumination to enhance the yield of solar cells. In discussion with an LLM, the framework for quantum solar cells is outlined.

Using quantum illumination with entangled photons generated from sunlight can enhance the energy efficiency of a photoelectric cell in a couple of ways. Here are two potential approaches to exploit the correlation between the emitted electrons and the idler photon:

1. Measurement-Based Quantum Feedback Control

Description: Implement a measurement-based feedback system where the idler photon is used to assess the state of the system and optimize the conditions under which the signal photon interacts with the photoelectric cell.

How it Works:

- Correlation Measurement: By measuring the properties (e.g., polarization, phase) of the idler photon immediately after it is generated, you can infer the state of the corresponding signal photon that interacts with the photoelectric cell.

- Adaptive Adjustment: Use the information from the idler photon to adaptively adjust the operating parameters of the photoelectric cell (e.g., the bias voltage, illumination intensity, or the angle of incidence). This could involve real-time tuning to maximize the photocurrent based on the correlation detected.

- Enhanced Efficiency: By optimizing these parameters in real time based on the quantum correlation, you can improve the cell's efficiency in converting photons into electrons, thus increasing the overall energy yield.

2. Entangled Photon-Assisted Stimulated Emission

Description: Use the idler photon to induce stimulated emission in the photoelectric material, enhancing the probability of electron generation when the signal photon hits the cell.

How it Works:

- Stimulated Emission Mechanism: When the signal photon is incident on the photoelectric cell, if the idler photon is simultaneously interacting with the same medium (or through a coherent coupling), it can stimulate the emission of electrons through stimulated emission rather than just absorption.

- Resonant Interaction: Ensure that the energy of the idler photon matches the energy levels involved in the electron transitions in the material. This resonance can enhance the overall efficiency of the energy conversion process.

- Higher Yield: By using the entangled state to create a coherent interaction that boosts the electron emission rate when the signal photon is absorbed, you can effectively increase the number of electrons generated for a given amount of incident light.

Summary

Both of these approaches leverage the quantum correlations between the entangled photons to enhance the efficiency of energy conversion in the photoelectric cell. The measurement-based feedback allows for dynamic adjustments to the system, while the stimulated emission mechanism can increase the rate of electron generation, ultimately contributing to a more efficient quantum-enhanced solar power system.