

MASTER THESIS TOPIC

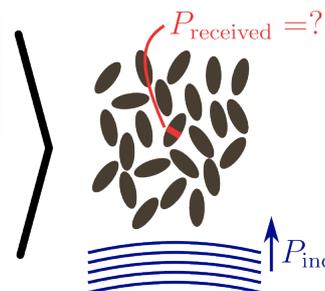
Available Power Analysis for a Tag in a Bee Cluster under mmWave Exposure: A Computational Study

March 2026

During cold winter months, honeybees form a tightly packed cluster to maintain and regulate their internal temperature. To sustain this thermoregulation, they consume stored honey as their primary energy source, moving through the hive in search of food reserves. Tracking a single bee within such a cluster is a challenging yet highly intriguing objective, requiring a wireless tag for identification and localization.



Cluster of Bees in Winter



Simulation Model

This study investigates the maximum power that a wireless tag—mounted on the dorsal surface of a single bee—can potentially receive when the bee is located within a bee cluster. For modeling purposes, individual bees are approximated as ellipsoidal bodies with homogeneous material properties. The bee cluster is then illuminated by a millimeter-wave (mmWave) electromagnetic field, while the received power is determined by integrating the time-averaged Poynting vector over an aperture matching the tag's effective receiving area, enabling a quantitative assessment of harvestable electromagnetic power in a bio-inspired cluster environment.

This topic is highly research-oriented, and accordingly, a scientific, structured approach to both execution and documentation is of utmost importance.

Requirements: • Prior experience working with electromagnetic fields, • Solid understanding of numerical field computation methods, • Proficiency in using MATLAB or Python for data analysis and visualization, • Ability to independently study scientific literature • Willingness to actively contribute new research questions based on emerging results

Of course, you will not be left to work on the topic independently. Regular meetings will be held to discuss your progress, clarify open questions, and to define the next steps.

If you are interested, please do not hesitate to contact us. With your strong personal interest in the subject—and the drive to explore complex questions deeply—we can achieve meaningful scientific progress together.

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