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## Note

# Comprehensive *T*-matrix reference database: A 2009–2011 update

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## ABSTRACT

The *T*-matrix method is one of the most versatile and efficient theoretical techniques widely used for the computation of electromagnetic scattering by single and composite particles, discrete random media, and particles in the vicinity of an interface separating two half-spaces with different refractive indices. This paper presents an update to the comprehensive database of peer-reviewed *T*-matrix publications compiled by us previously and includes the publications that appeared since 2009. It also lists several earlier publications not included in the original database.

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## 1. Introduction

The initial database of *T*-matrix publications appeared in 2004 [1] and was followed by three updates [2–4]. As evidenced by numerous citations, this database has proved to be very useful, thereby justifying the current update. The total number of newly added references is 289 [5–293]. They mostly represent publications that appeared since 2009 plus a few publications omitted inadvertently in Refs. [1–4].

As in Refs. [1–4], the database has been compiled using the following general restrictions:

- The database contains only publications dealing with electromagnetic scattering.
- In general, publications on scattering by isolated infinite cylinders and systems of parallel infinite cylinders in unbounded space are excluded.
- Publications on the Lorenz–Mie theory and its various extensions to radially inhomogeneous spherically symmetric scatterers are not included.

- The database contains only references to books, peer-reviewed book chapters, and peer-reviewed journal papers.

Furthermore, we have continued to use the following operational definition of the *T*-matrix method:

In the *T*-matrix method, the incident and scattered electric fields are expanded in series of suitable vector spherical wave functions, and the relation between the columns of the respective expansion coefficients is established by means of a transition matrix (or *T* matrix). This concept can be applied to the entire scatterer as well as to separate parts of a composite scatterer.

Obviously, this definition is more inclusive than the original notion of the extended boundary condition method [294].

As before, the various references are classified into a set of narrower subject categories. Following the methodology adopted in Refs. [1–4], we do not assess the validity and importance of the results described in the specific publications included in this database. As a consequence, the inclusion of a publication does not constitute any formal endorsement or quality certification. Also, we do not flag specifically those publications in which well known results (such as the superposition

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*T*-matrix method or certain symmetry and transformation properties of the *T* matrix) are re-discovered.

Among the many recent advances, we particularly note the following:

- The publication of two specialized monographs [211,218].
- The public release of a new version of the popular superposition *T*-matrix FORTRAN program intended for use on distributed memory computer clusters [151].
- Extensive use of the superposition *T*-matrix method for numerically exact computations of electromagnetic scattering by discrete random media, periodic multi-particle arrays, and morphologically complex multi-particle clusters.
- Theory and calculations of optical resonances in non-spherical particles and particle clusters.
- Calculations of optical forces and torques on small particles with application to optical traps.
- Extensive calculations of internal, surface, and local fields as well as near-field transfer of electromagnetic energy.
- Extensive use of the *T*-matrix method in analyses of laboratory data, including the results of controlled laboratory experiments.
- Extensive applications to the modeling of scattering properties of mineral and soot aerosols; cirrus cloud particles and hydrometeors; stratospheric and mesospheric aerosol and cloud particles; interstellar, interplanetary, and cometary dust particles, planetary regoliths, and planetary ring particles; biological microorganisms.

The full range of applications of the *T*-matrix method is, of course, significantly broader.

## 2. Particles in infinite homogeneous space

### 2.1. Books

[171,211,218]

### 2.2. Reviews

[52,79,119,144,172,179,253]

### 2.3. Extended boundary condition method and its modifications and generalizations

[53,61–63,68,70,92,101,202–206,218,219,236,237,264,282,284]

### 2.4. *T*-matrix theory and computations for anisotropic, chiral, magnetic, and charged scatterers

[118,133,134,233]

### 2.5. Superposition *T*-matrix method and its modifications, including related mathematical tools

[23,54,118,123,133,134,136,137,151,152,177,193,194,225]

### 2.6. *T*-matrix theory of electromagnetic scattering by periodic and aperiodic configurations of particles and photonic crystals

[39,83,86,126,137,192,242,257,258,275]

### 2.7. *T*-matrix theory and computations of electromagnetic scattering by discrete random media

[52,55,117,147,150,151,169,170,171,173,199,207,253,256,266]

### 2.8. Relation of the *T*-matrix method to other theoretical approaches

[17,61–63,85,145,218,219,265]

### 2.9. Symmetry properties of the *T*-matrix, analytical ensemble-averaging approaches, and linearization

[59,71,101,106,204,241]

### 2.10. Convergence of various implementations of the *T*-matrix method

[61,70,81,92,108,219,225,237]

### 2.11. *T*-matrix calculations for homogeneous spheroids

[5,7,9,13,15,16,21,22,24,27,29,34,35,37,38,47,53,56,62–68,70–74,76–79,88–91,93,96,102,103,110,112,115,124,125,128–131,135,146,155,157,159–165,167,173,175,181–184,187,197,201,204,208,210,212,216,217,218,224,227–229,233,238,239,241,246,248,251,254,259,261,262,268,270,272,276,279–281,284,287]

### 2.12. *T*-matrix calculations for Chebyshev and generalized Chebyshev particles

[8,60,62,63,101,102,209,218,241,280]

### 2.13. *T*-matrix calculations for finite circular cylinders

[6,11,12,18,60,64,71,82,113,153,162,173,218,230,242,257,258,274,277,280]

### 2.14. *T*-matrix calculations for various rotationally symmetric particles

[68,71,92,108,109,156,203,206,292,293]

### 2.15. *T*-matrix calculations for ellipsoids, polyhedral scatterers, and other particles lacking axial symmetry

[10,94,101,186,202,205,206]

2.16. *T*-matrix calculations for layered and composite particles

[5,35,142,152,249,250,271,282]

2.17. *T*-matrix calculations for clusters of homogeneous spheres

[8,19,21,25,26,30,32,33,40–43,45–52,55,69,75,83,86,97–100,111,114–117,120,122,126,132,138–140,147,148,150,151,154,166,168,169,170,173–175,178,185,191,195,196,199,207,214,215,221–223,225,226,231,234,235,240,243–245,253,255,260,266,273,275,278,283,285,288,289]

2.18. *T*-matrix calculations for clusters of layered, anisotropic, and chiral spheres

[23,118,136,137,152]

2.19. *T*-matrix calculations for clusters of nonspherical monomers

[39]

2.20. *T*-matrix calculations for particles with one or several (eccentric) inclusions

[107,141,249,269,271]

2.21. *T*-matrix calculations of optical resonances in nonspherical particles

[30,32,83,109,141,154,195,196,215,216,223,226,238,239,255,271,273,275]

2.22. *T*-matrix calculations of optical forces and torques on small particles

[11,12,104,143,156,178,179,188,190,198,213,223,232,233,245,286]

2.23. *T*-matrix calculations of internal, surface, and local fields and near-field energy exchange

[19,28,33,48,49,53,61,68,137,151,152,177,221,225,269]

2.24. Illumination by focused beams and non-plane waves

[11,23,85,104,107,133,143,150,178,198,213,232,269,271,286]

2.25. Use of *T*-matrix calculations for testing other theoretical techniques

[6,16,35,41–43,60,62,68,94,95,114,122,139,140,148,166,189,196,204,233,240,273,281,290]

2.26. Comparisons of *T*-matrix and effective-medium-approximation results

[55,122,142,180]

2.27. Comparisons of *T*-matrix and controlled laboratory results

[111,120,166,216,260]

2.28. Use of *T*-matrix calculations for analyzing laboratory data

[8,25,26,29,69,77–79,88,102,104,110,154,159,161,178,187,188,217,220,230,240,244,272,273,292,293]

2.29. *T*-matrix modeling of scattering properties of mineral aerosols in the terrestrial atmosphere and soil particles

[10,15,20,24,31,37,58,67,72–74,76,89,90,96,103,110,112,125,155,161–163,165,168,174,181,182,184,186,212,214,227,228,230,247,248,251,254,261,262,268,276,287]

2.30. *T*-matrix modeling of scattering properties of carbonaceous and soot aerosols and soot-containing aerosol and cloud particles

[5,40,42,43,97–100,132,138–140,142,148,168,249,280,288,289]

2.31. *T*-matrix modeling of scattering properties of cirrus cloud particles

[22,57,82,158,229,274]

2.32. *T*-matrix modeling of scattering properties of hydrometeors and atmospheric radar targets

[13,21,27,34–36,57,80,84,105,121,127–129,130,131,135,164,200,224,252,259,267,279,291]

2.33. *T*-matrix modeling of scattering properties of terrestrial stratospheric aerosol and cloud particles

[124,208]

2.34. *T*-matrix modeling of scattering properties of noctilucent cloud particles

[14,91,93,160,201]

2.35. *T*-matrix modeling of scattering properties of hydrosol particles

[7,113,146,157]

2.36. *T*-matrix modeling of scattering properties of aerosol and cloud particles in planetary atmospheres

[44,153,234,235,263,277]

### 2.37. *T*-matrix modeling of scattering properties of interstellar, interplanetary, cometary, and planetary-ring particles

[38,45–47,51,114–116,118,147,191]

### 2.38. *T*-matrix computations for industrial and military applications

[167,209]

### 2.39. *T*-matrix computations for biomedical applications

[7,29,56,64–66,79,126,187,190,209,213,244,246,272]

### 2.40. *T*-matrix computations of anisotropic and aggregation properties of colloids and other disperse media

[55,69,108,111,278,283,293]

## 3. Particles near infinite interfaces

### 3.1. Spherically symmetric particles

[149,176]

### 3.2. Finite particles on incident side of planar interface

[149,176]

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