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Entanglement for moving three-level atom under decoherence effect (Article)

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Abstract

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We discuss the dynamical properties of quantum entanglement and partial entropy for moving three-level atom interacting with single-mode quantized field inside a phase-damped cavity for more general cases. The results show that the atomic motion and decoherence effects play an important role on the evolution of the system dynamics and quantum entanglement. Moreover, we show that the phenomena of long lived nonlocal correlation and short temporal disentanglement can be generated through specific values of phase damping and atomic motion parameter. Copyright © 2015 American Scientific Publishers.

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Entanglement Negativity Phase Damping Von Neumann Entropy

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- 
- ☐ 1 Barnett, S.M., Knight, P.L.  
Dissipation in a fundamental model of quantum optical resonance  
  
(1986) *Physical Review A*, 33 (4), pp. 2444-2448. Cited 251 times.  
doi: 10.1103/PhysRevA.33.2444  
  
[View at Publisher](#)
- 
- ☐ 2 Puri, R.R., Agarwal, G.S.  
Finite-Q cavity electrodynamics: Dynamical and statistical aspects  
  
(1987) *Physical Review A*, 35 (8), pp. 3433-3449. Cited 187 times.  
doi: 10.1103/PhysRevA.35.3433  
  
[View at Publisher](#)
- 
- ☐ 3 Bougouffa, S., Kamli, A.  
An analytic approach to a three-level atom interacting with a single-mode quantized field  
  
(2004) *Journal of Optics B: Quantum and Semiclassical Optics*, 6 (3), pp. S60-S65. Cited 13 times.  
doi: 10.1088/1464-4266/6/3/010  
  
[View at Publisher](#)
- 
- ☐ 4 Quang, T., Knight, P.L., Buzek, V.  
(1991) *Phys. Rev. A*, 44, p. 6069. Cited 15 times.
- 
- ☐ 5 Eiselt, J., Risken, H.  
Quasiprobability distributions for the Jaynes-Cummings model with cavity damping  
  
(1991) *Physical Review A*, 43 (1), pp. 346-360. Cited 164 times.  
doi: 10.1103/PhysRevA.43.346  
  
[View at Publisher](#)
- 
- ☐ 6 Englert, B.-G., Naraschewski, M., Schenzle, A.  
Quantum-optical master equations: An interaction picture  
  
(1994) *Physical Review A*, 50 (3), pp. 2667-2679. Cited 40 times.  
doi: 10.1103/PhysRevA.50.2667  
  
[View at Publisher](#)
- 
- ☐ 7 Werlang, T., Souza, S., Fanchini, F.F., Villas Boas, C.J.  
Robustness of quantum discord to sudden death  
  
(2014) *Physical Review A - Atomic, Molecular, and Optical Physics*, 80 (2), art. no. 024103. Cited 372 times.  
<http://pra.aps.org/>  
doi: 10.1103/PhysRevA.80.024103  
  
[View at Publisher](#)
- 
- ☐ 8 Maziero, J., Céleri, L.C., Serra, R.M., Vedral, V.  
Classical and quantum correlations under decoherence  
  
(2009) *Physical Review A - Atomic, Molecular, and Optical Physics*, 80 (4), art. no. 044102. Cited 308 times.  
[http://oai.aps.org/oai?](http://oai.aps.org/oai?verb=GetRecord&Identifier=oai:aps.org:PhysRevA.80.044102&metadataPrefix=oai_apsmeta_2)  
[verb=GetRecord&Identifier=oai:aps.org:PhysRevA.80.044102&metadataPrefix=oai\\_apsmeta\\_2](http://oai.aps.org/oai?verb=GetRecord&Identifier=oai:aps.org:PhysRevA.80.044102&metadataPrefix=oai_apsmeta_2)  
doi: 10.1103/PhysRevA.80.044102  
  
[View at Publisher](#)
-

- ☐ 9 Berrada, K., Fanchini, F.F., Abdel-Khalek, S.  
Quantum correlations between each qubit in a two-atom system and the environment in terms of interatomic distance  
(2012) *Physical Review A - Atomic, Molecular, and Optical Physics*, 85 (5), art. no. 052315. Cited 34 times.  
<http://oai.aps.org/filefetch?identifier=10.1103/PhysRevA.85.052315&component=fulltext&description=markup&format=xml>  
doi: 10.1103/PhysRevA.85.052315  
[View at Publisher](#)
- 
- ☐ 10 Berrada, K., Eleuch, H., Hassouni, Y.  
Asymptotic dynamics of quantum discord in open quantum systems  
(2011) *Journal of Physics B: Atomic, Molecular and Optical Physics*, 44 (14), art. no. 145503. Cited 26 times.  
[http://iopscience.iop.org/0953-4075/44/14/145503/pdf/0953-4075\\_44\\_14\\_145503.pdf](http://iopscience.iop.org/0953-4075/44/14/145503/pdf/0953-4075_44_14_145503.pdf)  
doi: 10.1088/0953-4075/44/14/145503  
[View at Publisher](#)
- 
- ☐ 11 Berrada, K.  
Classical and quantum correlations for two-mode coherent-state superposition  
(2012) *Optics Communications*, 285 (8), pp. 2227-2235. Cited 19 times.  
doi: 10.1016/j.optcom.2011.12.054  
[View at Publisher](#)
- 
- ☐ 12 Salles, A., De Melo, F., Retamal, J.C., De Matos Filho, R.L., Zagury, N.  
Single observable concurrence measurement without simultaneous copies  
(2006) *Physical Review A - Atomic, Molecular, and Optical Physics*, 74 (6), art. no. 060303. Cited 9 times.  
[http://oai.aps.org/oai?verb=GetRecord&Identifier=oai:aps.org:PhysRevA.74.060303&metadataPrefix=oai\\_apsmeta\\_2](http://oai.aps.org/oai?verb=GetRecord&Identifier=oai:aps.org:PhysRevA.74.060303&metadataPrefix=oai_apsmeta_2)  
doi: 10.1103/PhysRevA.74.060303  
[View at Publisher](#)
- 
- ☐ 13 Gühne, O., Hyllus, P., Bruß, D., Ekert, A., Lewenstein, M., Macchiavello, C., Sanpera, A.  
Detection of entanglement with few local measurements  
(2002) *Physical Review A - Atomic, Molecular, and Optical Physics*, 66 (6), art. no. 062305, pp. 623051-623055. Cited 151 times.  
<http://pra.aps.org/>  
[View at Publisher](#)
- 
- ☐ 14 Horodecki, P., Ekert, A.  
Method for direct detection of quantum entanglement  
(2002) *Physical Review Letters*, 89 (12), art. no. 127902, pp. 1279021-1279024. Cited 149 times.  
doi: 10.1103/PhysRevLett.89.127902  
[View at Publisher](#)
- 
- ☐ 15 Horodecki, M., Horodecki, P., Horodecki, R.  
Separability of mixed states: Necessary and sufficient conditions  
(1996) *Physics Letters, Section A: General, Atomic and Solid State Physics*, 223 (1-2), pp. 1-8. Cited 2253 times.  
[View at Publisher](#)
-

- ☐ 16 Horodecki, P.  
**Measuring quantum entanglement without prior state reconstruction**

(2003) *Physical Review Letters*, 90 (16), pp. 167901/1-167901/4. Cited 70 times.

[View at Publisher](#)

---

- ☐ 17 Cai, J.M., Zhou, Z.W., Guo, G.C.  
(2006) *Phys. Rev. A*, 73, p. 024301.

- ☐ 18 Wootters, W.K.  
**Entanglement of formation of an arbitrary state of two qubits**

(1998) *Physical Review Letters*, 80 (10), pp. 2245-2248. Cited 4870 times.

[View at Publisher](#)

---

- ☐ 19 Berrada, K., Chafik, A., Eleuch, H., Hassouni, Y.  
**Entanglement of two-qubit nonorthogonal states**

(2009) *International Journal of Modern Physics B*, 23 (8), pp. 2021-2027. Cited 13 times.  
doi: 10.1142/S0217979209052169

[View at Publisher](#)

---

- ☐ 20 Walborn, S.P., Souto Ribeiro, P.H., Davidovich, L., Mintert, F., Buchleitner, A.  
**Experimental determination of entanglement with a single measurement**

(2006) *Nature*, 440 (7087), pp. 1022-1024. Cited 202 times.  
<http://www.nature.com/nature/index.html>  
doi: 10.1038/nature04627

[View at Publisher](#)

---

- ☐ 21 Vidal, G., Werner, R.F.  
**Computable measure of entanglement**

(2002) *Physical Review A - Atomic, Molecular, and Optical Physics*, 65 (3), art. no. 032314, pp. 1-11. Cited 177 times.  
doi: 10.1103/PhysRevA.65.032314

[View at Publisher](#)

---

- ☐ 22 Vedral, V., Plenio, M.B.  
**Entanglement measures and purification procedures**

(1998) *Physical Review A - Atomic, Molecular, and Optical Physics*, 57 (3), pp. 1619-1633. Cited 873 times.

[View at Publisher](#)

---

- ☐ 23 Berrada, K., El Baz, M., Eleuch, H., Hassouni, Y.  
**A comparative study of negativity and concurrence based on spin coherent states**

(2010) *International Journal of Modern Physics C*, 21 (3), pp. 291-305. Cited 36 times.  
doi: 10.1142/S0129183110015129

[View at Publisher](#)

---

☐ 24 Peres, A.  
Separability criterion for density matrices  
(1996) *Physical Review Letters*, 77 (8), pp. 1413-1415. Cited 2807 times.  
<https://journals.aps.org/prl/issues>  
doi: 10.1103/PhysRevLett.77.1413  
[View at Publisher](#)

---

☐ 25 Zubairy, M.S., Agarwal, G.S., Scully, M.O.  
Quantum disentanglement eraser: A cavity QED implementation  
(2004) *Physical Review A - Atomic, Molecular, and Optical Physics*, 70 (1), art. no. 012316, pp. 012316-1-012316-4. Cited 26 times.  
doi: 10.1103/PhysRevA.70.012316  
[View at Publisher](#)

---

☐ 26 Bose, P.K., Paitya, N., Bhattacharya, S., De, D., Saha, S., Chatterjee, K.M., Pahari, S., (...), Ghatak, K.P.  
(2012) *Quantum Matter*, 1, p. 89. Cited 359 times.

---

☐ 27 Tüzün, B., Erkoç, C.  
(2012) *Quantum Matter*, 1, p. 136. Cited 350 times.

---

☐ 28 Ono, T., Fujimoto, Y., Tsukamoto, S.  
(2012) *Quantum Matter*, 1, p. 4. Cited 419 times.

---

☐ 29 Narayanan, M., John Peter, A.  
(2012) *Quantum Matter*, 1, p. 53. Cited 338 times.

---

☐ 30 Ghatak, K.P., Bhattacharya, S., Mondal, A., Debbarma, S., Ghorai, P., Bhattacharjee, A.  
(2013) *Quantum Matter*, 2, p. 25. Cited 64 times.

---

☐ 31 Herman, A.  
(2013) *Rev. Theor. Sci.*, 1, p. 3. Cited 263 times.

---

☐ 32 Pankratov, E.L., Bulaeva, E.A.  
(2013) *Rev. Theor. Sci.*, 1, p. 58. Cited 272 times.

---

☐ 33 Fisaletti, D.  
(2013) *Rev. Theor. Sci.*, 1, p. 103. Cited 77 times.

---

☐ 34 Pankratov, E.L., Bulaeva, E.A.  
(2013) *Rev. Theor. Sci.*, 1, p. 307. Cited 69 times.

---

☐ 35 Khrennikov, A.  
(2013) *Rev. Theor. Sci.*, 1, p. 34. Cited 217 times.

---

□ 36 Gardiner, C.W.  
(1991) *Quantum Noise Berlin*. Cited 2 times.  
Springer

---

□ 37 Walls, D.F., Milburn, G.J.  
(1994) *Quantum Optics*. Cited 3788 times.  
Berlin, Springer

---

□ 38 Breuer, H.-P., Dorner, U., Petruccione, F.  
**Numerical integration methods for stochastic wave function equations**  
  
(2000) *Computer Physics Communications*, 132 (1-2), pp. 30-43. Cited 29 times.  
doi: 10.1016/S0010-4655(00)00135-1  
  
[View at Publisher](#)

---

□ 39 Chuang, I.L., Yamamoto, Y.  
**Creation of a persistent quantum bit using error correction**  
  
(1997) *Physical Review A - Atomic, Molecular, and Optical Physics*, 55 (1), pp. 114-127. Cited 54 times.  
  
[View at Publisher](#)

---

□ 40 Kuang, L.-M., Chen, X., Chen, G.-H., Ge, M.-L.  
**Jaynes-Cummings model with phase damping**  
  
(1997) *Physical Review A - Atomic, Molecular, and Optical Physics*, 56 (4), pp. 3139-3149. Cited 58 times.  
  
[View at Publisher](#)

---

□ 41 Obada, A.-S.F., Hessian, H.A., Mohamed, A.-B.A.  
**Influence of phase damping on the entanglement for the damped JC model in the pure and mixed states**  
  
(2008) *Laser Physics*, 18 (9), pp. 1111-1117. Cited 11 times.  
doi: 10.1134/S1054660X08090193  
  
[View at Publisher](#)

---

□ 42 Obada, A.-S.F., Hessian, H.A., Mohamed, A.-B.A.  
**Effect of phase-damped cavity on dynamics of tangles of a nondegenerate two-photon JC model**  
  
(2008) *Optics Communications*, 281 (20), pp. 5189-5193. Cited 11 times.  
doi: 10.1016/j.optcom.2008.06.076  
  
[View at Publisher](#)

---

□ 43 Hessian, H.A., Ritsch, H.  
**Influence of phase damping on nonclassical properties of the two-mode Jaynes-Cummings model**  
  
(2002) *Journal of Physics B: Atomic, Molecular and Optical Physics*, 35 (22), pp. 4619-4635. Cited 20 times.  
doi: 10.1088/0953-4075/35/22/305  
  
[View at Publisher](#)

---

□ 44 Ritsch, H., Hessian, H.A.  
**Influence of phase damping in the presence of stark shift on nonclassical properties of the two-mode JCM**  
  
(2003) *Acta Physica Slovaca*, 53 (1), pp. 61-79. Cited 10 times.

---

- 45 Obada, A.-S.F., Hessian, H.A., Mohamed, A.-B.A.

### Entropy and entanglement in the Jaynes-Cummings model with effects of cavity damping

(2008) *Journal of Physics B: Atomic, Molecular and Optical Physics*, 41 (13), art. no. 135503. Cited 7 times.  
doi: 10.1088/0953-4075/41/13/135503

[View at Publisher](#)

---

- 46 Obada, A.-S.F., Hessian, H.A., Mohamed, A.-B.A.

### Entropies and entanglement for decoherence without energy relaxation in a two-level atom

(2007) *Journal of Physics B: Atomic, Molecular and Optical Physics*, 40 (12), art. no. 002, pp. 2241-2248. Cited 20 times.  
doi: 10.1088/0953-4075/40/12/002

[View at Publisher](#)

---

- 47 Obada, A.-S.F., Hessian, H.A., Mohamed, A.-B.A.

(2009) *J. Mod. Opt.*, 56, p. 1362. Cited 3 times.

---

- 48 Abdel-Khalek, S., Nofal, T.A.

### Correlation and entanglement of a three-level atom inside a dissipative cavity

(2011) *Physica A: Statistical Mechanics and its Applications*, 390 (13), pp. 2626-2635. Cited 7 times.  
doi: 10.1016/j.physa.2011.02.030

[View at Publisher](#)

---

- 49 Yoo, H.-I., Eberly, J.H.

### Dynamical theory of an atom with two or three levels interacting with quantized cavity fields

(1985) *Physics Reports*, 118 (5), pp. 239-337. Cited 633 times.  
doi: 10.1016/0370-1573(85)90015-8

[View at Publisher](#)

---

- 50 Puri, R.R.

### Exact dynamics of a class of two-level and three-level atoms interacting with quantized field

(1999) *Journal of Modern Optics*, 46 (10), pp. 1465-1481. Cited 9 times.  
doi: 10.1080/09500349908231348

[View at Publisher](#)

---

- 51 Abdel-Khalek, S., El-Saman, Y.S., Abdel-Aty, M.

### Geometric phase of a moving three-level atom

(2010) *Optics Communications*, 283 (9), pp. 1826-1831. Cited 18 times.  
doi: 10.1016/j.optcom.2009.12.065

[View at Publisher](#)

---

- 52 Prants, S.V., Yacoupova, L.S.

### The jaynes-cummings model with modulated field-atom coupling in resonator quantum electrodynamics

(1992) *Journal of Modern Optics*, 39 (5), pp. 961-971. Cited 20 times.  
doi: 10.1080/09500349214550991

[View at Publisher](#)

---

- 53 Sargent, M., Scully, M.O., Lamb, W.E.  
(1974) *Laser Physics*, Addison-Wesley. Cited 17 times.  
Reading/Mass

- 
- 54 Li, X.-S., Lin, D.L., Gong, C.-D.  
Nonresonant interaction of a three-level atom with cavity fields. I. General formalism and level occupation probabilities  
  
(1987) *Physical Review A*, 36 (11), pp. 5209-5219. Cited 66 times.  
doi: 10.1103/PhysRevA.36.5209  
  
View at Publisher

- 
- 55 Enaki, N.A., Ciobanu, N.  
Quantum trapping conditions for three-level atom flying through bimodal cavity field  
  
(2008) *Journal of Modern Optics*, 55 (10), pp. 1557-1569. Cited 8 times.  
doi: 10.1080/09500340701721868  
  
View at Publisher

- 
- 56 Schlicher, R.R.  
Jaynes-Cummings model with atomic motion  
  
(1989) *Optics Communications*, 70 (2), pp. 97-102. Cited 116 times.  
doi: 10.1016/0030-4018(89)90276-9  
  
View at Publisher

- 
- 57 Englert, B.G.  
(2002) *Elements of Micromaser Physics*. Cited 7 times.  
arXiv:quant-ph/0203052 March  
<http://arxiv.org/abs/quant-ph/0203052>

- 
- 58 Li, X.-S., Lin, D.L., Gong, C.-D.  
Nonresonant interaction of a three-level atom with cavity fields. I. General formalism and level occupation probabilities  
  
(1987) *Physical Review A*, 36 (11), pp. 5209-5219. Cited 66 times.  
doi: 10.1103/PhysRevA.36.5209  
  
View at Publisher

- 
- 59 Sargent, M., Scully, M.O., Lamb, W.E.  
(1974) *Laser Physics*. Cited 2246 times.  
Addison-Wesley, Reading/Mass.

- 
- 60 Hood, C.J., Chapman, M.S., Lynn, T.W., Kimble, H.J.  
Real-time cavity QED with single atoms  
  
(1998) *Physical Review Letters*, 80 (19), pp. 4157-4160. Cited 285 times.  
  
View at Publisher

- 
- 61 Englert, B.-G., Schwinger, J., Barut, A.O., Scully, M.O.  
Reflecting slow atoms from a micromaser field  
  
(1991) *EPL*, 14 (1), pp. 25-31. Cited 113 times.  
doi: 10.1209/0295-5075/14/1/005  
  
View at Publisher
-



- 62 Haroche, S., Brune, M., Raimond, J.M.  
Trapping atoms by the vacuum field in a cavity.

(1991) *EPL*, 14 (1), pp. 19-24. Cited 29 times.  
doi: 10.1209/0295-5075/14/1/004

[View at Publisher](#)

- 63 Liu, X.  
Entropy behaviors and statistical properties of the field interacting with a  $\Xi$ -type three-level atom

(2000) *Physica A: Statistical Mechanics and its Applications*, 286 (3), pp. 588-598. Cited 29 times.  
doi: 10.1016/S0378-4371(00)00302-2

[View at Publisher](#)

- 64 Abdel-Aty, M., Obada, A.-S.F.  
Engineering entanglement of a general three-level system interacting with a correlated two-mode nonlinear coherent state

(2003) *European Physical Journal D*, 23 (1), pp. 155-165. Cited 39 times.  
doi: 10.1140/epjd/e2003-00011-3

[View at Publisher](#)

- 65 Abdel-Khalek, S., Obada, A.-S.F.  
New features of Wehrl entropy and Wehrl PD of a single Cooper-pair box placed inside a dissipative cavity

(2010) *Annals of Physics*, 325 (11), pp. 2542-2549. Cited 27 times.  
doi: 10.1016/j.aop.2010.05.011

[View at Publisher](#)

- 66 Bougouffa, S., Al-Awfi, S.  
Dynamical aspects in the optical bloch equations

(2008) *European Physical Journal: Special Topics*, 160 (1), pp. 43-50. Cited 2 times.  
doi: 10.1140/epjst/e2008-00708-9

[View at Publisher](#)

- 67 Schmidt, E.  
(1906) *Math. Annalen.*, 63, p. 433. Cited 12 times.

- 68 Bennett, C.H., Bernstein, H.J., Popescu, S., Schumacher, B.  
Concentrating partial entanglement by local operations

(1996) *Physical Review A - Atomic, Molecular, and Optical Physics*, 53 (4), pp. 2046-2052. Cited 1744 times.

[View at Publisher](#)

- 69 Vollbrecht, K.G.H., Wolf, M.M.  
Conditional entropies and their relation to entanglement criteria

(2002) *Journal of Mathematical Physics*, 43 (9), pp. 4299-4306. Cited 41 times.  
doi: 10.1063/1.1498490

[View at Publisher](#)

- 70 Neumann, V.J.  
(1955) *Mathematical Foundations of Quantum Mechanics*. Cited 3275 times.  
Princeton University Press, Princeton, NJ

- ☐ 71 Phoenix, S.J.D., Knight, P.L.  
Establishment of an entangled atom-field state in the Jaynes-Cummings model

(1991) *Physical Review A*, 44 (9), pp. 6023-6029. Cited 392 times.  
doi: 10.1103/PhysRevA.44.6023

[View at Publisher](#)

- ☐ 72 Phoenix, S.J.D., Knight, P.L.  
Comment on Collapse and revival of the state vector in the Jaynes-Cummings model:  
An example of state preparation by a quantum apparatus

(1991) *Physical Review Letters*, 66 (21), p. 2833. Cited 207 times.  
doi: 10.1103/PhysRevLett.66.2833

[View at Publisher](#)

- ☐ 73 Phoenix, S.J.D., Knight, P.L.  
Fluctuations and entropy in models of quantum optical resonance


(1988) *Annals of Physics*, 186 (2), pp. 381-407. Cited 422 times.  
doi: 10.1016/0003-4916(88)90006-1

[View at Publisher](#)

- ☐ 74 Vidal, G., Werner, R.F.  
Computable measure of entanglement

(2002) *Physical Review A - Atomic, Molecular, and Optical Physics*, 65 (3), art. no. 032314, pp. 1-11. Cited 177 times.  
doi: 10.1103/PhysRevA.65.032314

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