Olga Kocharovskaya
RESEARCH

CURRENT RESEARCH INTERESTS:
Quantum coherence effects such as EIT, slow light, LWI, etc. (in atomic gases, rare-earth and transition-metal ions doped solids, nuclear transitions in solids) and their applications.

CURRENT FUNDING
NSF: 2003-2009; AFSOR: 2002-2008, CRDF: 2007-2009.

CURRENT GROUP MEMBERS:
Dr. Farit Vagizov, Senior Research Scientist,
Petr Anisimov, Ph D Student,
Chris O'Brien, Ph D Student

FORMER GROUP MEMBERS:

Alexei Belyanin, currently Associate Professor, Department of Physics, TAMU
Yuri Rostovtsev, currently Research Professor, TEES, TAMU
Victor Kozlov, currently Associate Professor, St.-Petersburg State University, Russia
Yuvgeny Radeonychev , currently Associate Professor, Nizhny Novgorod State University, Russia
Silviu Olariu, currently Senior Research Scientist, Institute of Nuclear Physics, Romania.
Roman Kolesov, currently postdoc at the University of Stuttgart
Elena Kuznetsova, currently postdoctoral fellow at the University of Connecticut and visiting scientist at ITAMP

MAJOR SCIENTIFIC RESULTS

Lasing without inversion (LWI)
1988 - prediction of the possibility of light amplification and lasing without population inversion (LWI) in a three-level lambda type medium due to atomic interference suppressing resonant absorption (O.Kocharovskaya, Ya.I.Khanin, JETP Lett., 1988, v.48, p.630). This prediction was confirmed experimentally (A.Nottelman et al., PRL, v.70, p.1783,1993) and followed by many further theoretical and experimental works worldwide. Currently the focus of this research is on realization of the far-infrared generation in semiconductors and X-ray lasing where population inversion is difficult to obtain because of fast decay of the excited state.

Electromagnetically Induced Transparency (EIT)
1986 and 1990 - pioneering theoretical works on the electromagnetically induced transparency (EIT) for a train of ultrashort pulses (O.Kocharovskaya, Ya.I.Khanin, Sov. Phys. JETP, 1986, v.63, p.945) and CW bichromatic radiation (O.Kocharovskaya and P.Mandel, Phys.Rev. A 42, 1990, p.523) propagating through the optically thick lambda type medium in the vicinity of a two-photon resonance. Experimentally EIT was discovered by S. Harris (S.Harris et al., PRL, 1990). Nowdays EIT became a common technique which has numerous applications such as nonlinear optics at maximum atomic coherence, high precision magnetometry, quantum information processing, etc.

Coherent Control of the Gamma-Ray Nuclear Transition

1999 - prediction of the possibility of efficient laser manipulation of gamma-ray nuclear transitions based on the resonant laser driving of the electronic transitions and hyperfine coupling between electronic and nuclear degrees of freedom (O.Kocharovskaya, R.Kolesov, and Y.Rostovtsev, PRL, v.82, p.3593, 1999).

2002 - first experimental demonstration of EIT at the nuclear transitions in gamma-rays by collaboration of the Catholic Leuven University and TAMU groups (R.Coussement, ..., O.Kocharovskaya, PRL, v.89, p.107601, 2002.

2004-2007 experimental demonstration of the laser-induced modifications of the Mossbauer spectrum (F.Vagizov, et al., J. Mod. Opt., v.51, p.2579, 2004; Hyperfine Interactions, p.917,v.167,2006;Laser Phys., p.734, v.17, 2007.)

Freezing of a Light Pulse

2001 - prediction of the possibility to freeze the light pulse due to its Fizeau dragging by hot atoms in a stationary gaseous cell under EIT conditions (O.Kocharovskaya, et al., PRL, v.86, p.628, 2001). This prediction received an experimental proof at JET Propulsion Lab (D.Strekalov et al., PRL, 2004).

Generalized Master Equation and Field-Dependent Relaxation Effects

1994-1999 - generalization of the master equation for a multi-level atomic system for the case of a strong coupling with multi-frequency field (O.Kocharovskaya et al., Phys.Rev.A, v.49, p.4928, 1994) and prediction of the new effects caused by modification of the relaxation processes such as spontaneous radiation from the ground atomic level, population trapping at one of dynamical Stark level, high-refraction index in a combination with the vanishing absorption, the possibility of population inversion at the driven transition, etc. (O.Kocharovskaya et al., PRL, v.74, p.2451, 1995; O.Kocharovskaya and Y.V.Radeonychev, Quantum Semiclass. Opt., v.8, p.7, 1996; O.Kocharovskaya and Y.V.Radyonychev, Found. of Phys., v.28, p.561, 1998; O.Kocharovskya et al., Phys.Rev. A, v.60, p.3091, 1999).

Atomic Interference Phenomena in Solids

2002-2007 - extension of the theory of EIT, Slow Light and LWI to the solid materials (taking into account inhomogeneous broadening both at the resonant and two-photon transitions, the phonon line broadening, spin-spin and spin-lattice relaxation, etc.), E. Kuznetsova, O. Kocharovskaya, P. Hemmer, M.O. Scully, Phys.Rev. A, v.64, p.013814, 2001; suggestion of coherent control of the excited state absorption for realization of the new types of widely tunable solid-state lasers (E.Kuznetsova, R.Kolesov, and O.Kocharovskaya, Phys.Rev. A, v.70, p.043801, 2004); pioneering demonstration of EIT and Ramsey fringes in the room-temperature solids (R.Kolesov, M.O.Scully,O.Kocharovskaya, Phys.Rev.A, v.74, 053820, 2006).