TT 5: Superconductivity - Cryodetectors

Time: Monday 11:30–13:00 Location: H 3010

TT 5.1 Mon 11:30 H 3010

SABOCA - a multiplexed 37 channel bolometer camera for 350 micrometer wavelength — Torsten May[1], Viatcheslav Zakosarenko[1], Andre Krueger[1], Solveig Anders[1], Katja Peiselt[1], •Hans-Georg Meyer[1], Ernst Kreysa[2], Giorgio Siringo[2], and Walter Esch[2] — [1]Institute of Photonic Technology, Albert-Einstein-Str. 9, D-07745 Jena, Germany — [2]Max-Planck-Institute for radio astronomy, Auf dem Huegel 69, D-52888 Bonn, Germany

Some of the most interesting objects in the Universe are only accessible through astronomical observations in a so far only sparsely used atmospheric window at sub millimeter wavelengths. The sub millimeter emission from molecular spectral lines and from warm dust allows an almost unhindered, unique view onto ongoing star forming regions and galactic nuclei, from our own Milky Way to the most distant galaxies and quasars in the early Universe. One of the best accessible sites for submillimeter observations is the high plateau Llano de Chajnantor in Chile's Atacama desert. At 5000 meter altitude APEX (Atacama Pathfinder Experiment), a 12 meter radio telescope, has seen first light in 2005. Due to its high surface accuracy this instrument is particularly suited to utilize one of last atmospheric radio windows on earth: the 350 micron band. The Small Array BOlometer CAmera (SABOCA) is scheduled to operate at APEX in spring 2008. It is an array of 37 transition edge sensors operated at a temperature of 300 mK, provided by a 3He sorption cooler on a cryostat with liquid 4He. The instrument is read out by SQUID current sensors in a time domain multiplexing scheme. Four integrated multiplexer chips, 10 first stage SQUIDs each, are placed next to the detector chip, operating at the same temperature. Every multiplexer chip is coupled to one amplifier SQUID. The four amplifier SQUIDs are placed at the 4He stage, with a temperature of 1.5K during operation. The signals are acquired by room temperature electronics and digitized by 24bit A/D converters. The data acquisition system limits the system clock to 2 kHz, resulting in an effective data rate of 200 Hz per channel.

TT 5.2 Mon 12:00 H 3010

Numerical Optimization of the Energy Resolution of Magnetic Calorimeters — •J.-P. Porst, A. Burck, C. Domesle, C. Höhn, S. Kempf, S. Lausberg, A. Pabinger, C. Pies, S. Schäfer, R. Weldle, A. Fleischmann, L. Fleischmann, and C. Enss — Kirchhoff-Institut für Physik, INF 227, 69120 Heidelberg

We present numerical optimizations of the energy resolution of metallic magnetic calorimeters (MMC) with paramagnetic Au:Er temperature sensors. Energy deposited in such a detector leads to a change of magnetization of the paramagnetic sensor located in a weak magnetic field. SQUIDs are used to detect this change. The response of a MMC upon the deposition of energy depends on several parameters including the absorber heat capacity, the thermodynamic properties of the sensor material, and the geometry of the temperature sensor and the pickup loop. The specific heat and the magnetization of Au:Er can be calculated numerically with confidence. Furthermore, the following noise contributions are considered in these calculations: the thermodynamic fluctuations of energy, the magnetic Johnson noise, the flux noise of the SQUIDs and the 1/f-noise, so far observed in Au:Er-based MMCs. All mentioned noise contributions are parameterized. We performed a numerical optimization of the signal to noise ratio and thus the energy resolution of MMCs for different applications with absorber heat capacities ranging from 1 pJ/K to 1 nJ/K. The optimal parameters found, like shape and size of sensor and pickup coil, concentration of magnetic ions and the optimal magnetic field are presented. The contribution of each noise source to the detector performance is discussed.

TT 5.3 Mon 12:15 H 3010

SQUID based readout and characterization of superconducting single photon detectors — •Alexander Kirste[1], Dietmar Drung[1], Jörn Beyer[1], Margret Peters[1], Thomas Schurig[1], Philipp Haas[2], Alexei Semenov[2], Heinz-Wilhelm Hübers[2], Konstantin Ilin[3], Michael Siegel[3], Rudolf Herrmann[4], and Hans-Ulrich Müller[4] — [1]Physikalisch-Technische Bundesanstalt, Abbestr. 2-12, 10587 Berlin — [2]German Aerospace Center (DLR), Rutherfordstr. 2, 12489 Berlin — [3]University of Karlsruhe, Hertzstr. 16, 76187 Karlsruhe — [4]Institut für angewandte Photonik, Rudower Chaussee 29, 12489 Berlin

We report on the readout and the characterization of nanostructured superconducting single photon detectors using SQUID arrays.

As the detectors allow photon counting with a modest energy resolution, it is important to use preamplifiers of high bandwidth and low noise. For this purpose SQUID arrays are a favourable choice as they are intrinsically wide-band and offer a low noise.

For the detector readout we apply SQUID arrays containing up to 640 single SQUIDs. These arrays have a white flux noise of 0.06 $\mu\Phi_0/\mathrm{Hz}^{1/2}$ at 4.2 K and a low dynamic impedance so that they are adequate to drive a following broadband microwave amplifier. Since the relevant time constants of the detector and the resulting duration of the voltage transients are intrinsically sub-ns, the SQUID is operated in AMP mode rather than in FLL mode. Using the internal preamplifier of the SQUID electronics XXF-1 with 50 MHz bandwidth, the voltage pulses at the output have a duration of 13 ns (FWHM).

TT 5.4 Mon 12:30 H 3010

Development of a terahertz heterodyne receiver with a superconducting hot electron bolometric mixer and a quantum cascade laser — •Heiko Richter[1], Heinz-Wilhelm Hübers[1], Sergey Pavlov[1], Alexei Semenov[1], Kostea Il'in[2], Michael Siegel[2], Lukas Mahler[3], Alessandro Tredicucci[3], Harvey Beere[4], and David Ritchie[4] — [1]DLR, Institut für Planetenforschung, Rutherfordstr. 2, 12489 Berlin — [2]Institut für Mikro- und Nanoelektronische Systeme, Hertzstr. 16, 76187 Karlsruhe — [3]NEST-INFM and Scuola Normale Superiore,Piazza dei Cavalieri 7, 56126 Pisa, Italien — [4]Cavendish Laboratory, University of Cambridge, Madingley Road, Cambridge CB3 0HE, England

We will report on the development of a terahertz (THz) heterodyne receiver with a superconducting hot electron bolometric (HEB) mixer and a quantum cascade laser as local oscillator for applications in astronomy, planetary research or security. The intermediate frequency bandwidth, noise temperature and antenna pattern of the mixer have been measured at several frequencies between 0.6 and 5 THz. Based on these results we have started the development of a cryogen-free heterodyne receiver with the QCL and the HEB mixer mounted in the same pulse tube cooler. First results obtained with this system will be reported.

TT 5.5 Mon 12:45 H 3010

Performance enhancement of a superconducting nanowire single-photon detector at low temperatures — •Alexej Semenov[1], Phillip Haas[1], Heinz-Wilhelm Huebers[1], Konstantin Il'in[2], Michael Siegel[2], and Rudolf Herrmann[3] — [1]DLR Institute of Planetary Research, 12489 Berlin, Germany — [2]Institute of Micro- and Nano-Electronic Systems, University of Karlsruhe, 76187 Karlsruhe, Germany — [3]Institute of Appplied Photonics, 12489 Berlin, Germany

We report on the low-temperature operation of superconducting nanowire single-photon detectors. The nanowires were patterned from a 5-nm thick B1 niobium nitride film to form a 100-nm wide meander-line. NbN films had a quality assuring the Ginsburg-Landau deparing current in the detector structures at all temperature below the transition temperature. At 6 K operation, a resolution of 0.55 eV was measured in the wavelength range from 1000 nm to 1500 nm along with the quantum efficiency of a few percent for ultra-violet and visible-light quanta. Decreasing operation temperature to 1.4 K with a ^{3}He sorption refrigerator combined with a mechanical pulse-tube cooler, we found a threefold increase in the quantum efficiency and an almost 50% improvement of the energy resolution. The quantum efficiency at low temperatures was limited to the absorbance of the structure. Although the energy resolution and single-photon detection ability is better explained by an unbinding of vortex-antivortex pairs, the observed temperature enhancement of the detector perfermance is most likely due to the non-homogeneity of the meander-line.