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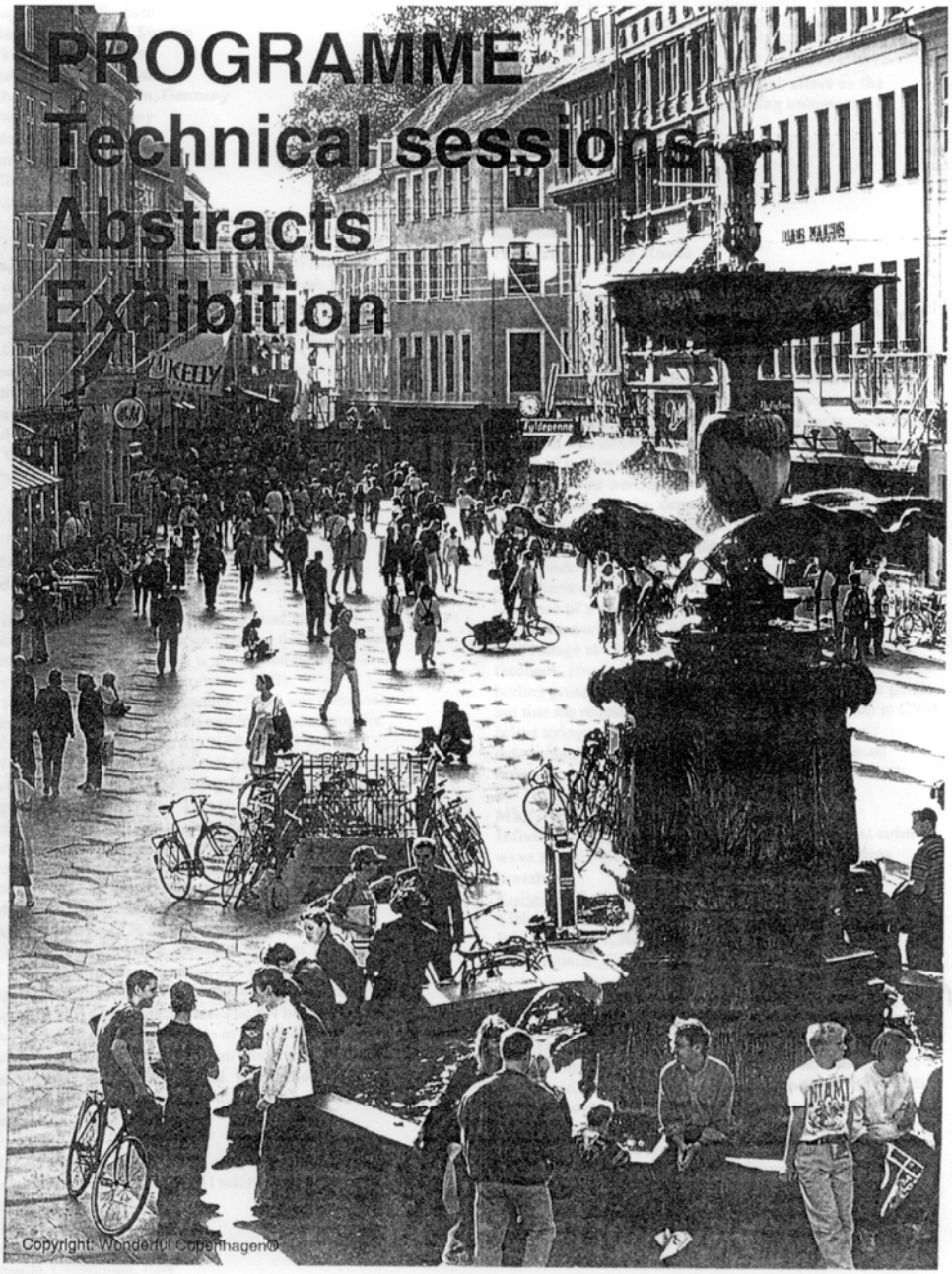
PROGRAMME
Technical sessions
Abstracts
Exhibition



POSTER SESSION M1.1

Other detectors

August 29th, 2001, 16:15-18:00

M1.1-01

1.6 THz HEB mixer for far infrared space telescope (Hershel)

Cherednichenko, Serguei, Sweden
Kroug, Matthias, Sweden
Khosropanah, Pourya, Sweden
Merkel, Harald, Sweden
Goltsman, Gregory, Russia
Huebers, Heinz-Wilhelm, Germany
Richter, Heiko, Germany
Wadefalk, Niklas, Sweden
Adam, Aurele, Sweden
Kollberg, Erik, Sweden
Voronov, Boris, Russia

1.5 THz quasioptical receiver has been developed for Far InfraRed Space Telescope (FIRST-Hershel). Phonon-cooled hot-electron bolometric (HEB) mixer made from thin NbN superconducting film was used for such a receiver. We investigated gain and noise bandwidths of NbN HEB mixer at LO frequencies of 0.6 THz 1.6 THz and 2.5 THz. DSB noise temperature of 20 quantum limits has been obtained at the mentioned frequency bands. The optimum bias conditions were found in order to reach the best sensitivity in the IF band of 4-8 GHz. Input losses, total conversion efficiency and output noise temperature were investigated as a function of the local oscillator frequency.

M1.1-03

Thermal flows in Andreev bolometer

Devyatov, Igor, Russia
Kupriyanov, Mikhail, Russia

An interest for studying of thermoelectrical effects in structures containing boundaries between normal (N) and superconducting (S) materials is stimulated now by developments of Andreev bolometers (AB).
Up to now the experimental studies of AB was focus only on measurements under a constant current. A promising for applications value of sensitivity NEP = 3*10^(-18) WHz^(1/2) at temperature 100 mK had been reported under this set up. However in interesting for radioastronomy frequency interval around 1 THz an absorption of electromagnetic radiation in absorber can have a quantum character resulting in generation of nonequilibrum, nonthermolised electron distribution function which is differ from a Fermi-like distribution.
In this paper we focus on calculations of a thermal flow across SN interfaces in a limiting case completely nonthermolised electron distribution function. Our analysis has shown that its form obtained as a result of a high-frequency irradiation, radically change thermoelectric properties of Andreev bolometer. The SN boundaries of the absorber are not more play a role of an effective "mirrors" like it was for a case of equilibrium electron distribution function and low frequency signal. It is also demonstrated that exited electrons loss energy to phonon subsystem with extremely high rate.

M1.1-08

Design and operation of Nb/Al microstrip detectors

Greco, Michela, Italy
Maggi, Sabino, Italy
Menichetti, Ezio, Italy
Rinaudo, Giuseppina, Italy
Fabbricatore, Pasquale, Italy

We have tested the efficiency of Nb/Al microstrips as radiation detectors.
The first devices were fabricated by superposing a 2 mm x 2 mm Al area on a 5 um wide, 100 um long Nb strip. We have designed a new geometry with a 2 mm long Nb meander line to implement Nb/Al detector arrays.
Steady and dynamical results are reported from tests of x-rays and alpha particle detection measurements. First results of investigations at low and high magnetic fields are shown.

M1.1-09

Estimation of electrothermal feedback effect on the operation of high-Tc superconducting bolometers of different types.

Ivanov, Konstantin, Russia
Lima, Antonio Marcus, Brazil
Neff, Helmut, Denmark
Deep, Gudrip, Brazil
Khrebtov, Igor, Russia
Tkachenko, Andrey, Russia

The computer simulation of the operation of the high-Tc superconducting bolometers in constant voltage (CVM) and constant current (CCM) modes was carried out. The parameters of practical bolometers on the solid substrate, microbolometers and membrane bolometers were used for calculations. The nonlinearity in the resistance versus temperature characteristics in region of the superconducting transition was taken into account in this simulation. The effects of temperature and biasing parameters on the operating point were studied. The dependence of the time constant, responsivity, detectivity and spectral noise power density as function of the biasing conditions were determined. A considerable decrease of the time constant (up to two orders of magnitude) and the increase of a linear dynamic range (one order of magnitude) in CVM under influence of a negative electrothermal feedback in comparison with the CCM was found. The increase of the bias voltage in CVM leads to an augmentation of negative feedback. However, this requires cooling of the sensor below boiling point of pool nitrogen (77K). It is necessary to point out that the requirement for temperature stabilization in CVM is less stringent than in CCM. This study permits to determine the optimal biasing conditions for enhanced bolometer performance in different infrared applications.

M1.1-10

Influence of thermal fluctuations on sensitivity of submm wave signal detection by bicrystal YBCO Josephson junctions.

Kislinskii, Yulii, Russia
Kislinskii, Yulii, Russia
Borisenko, Igor, Russia
Constantinian, Karen, Russia

Sensitivity of signal detection and self-pumping mixing have been studied experimentally at submm wave frequences for high-Tc superconducting device at high temperatures 65-77 K, for which thermal fuctuations are predominated. The device consists of YBCO bicrystal junction and log-periodic antenna, covered by thin film Pt layer to reduce a surface loss. Different operating modes were examined and compared: selective signal detection at 400-500 GHz, broad-band detection of noise signal, self-pumped frequency down conversion to 1-2 GHz intermediate frequency.
The work was supported in parts by Russian Fund for Basic Researsh, INTAS-OPEN/97-1940, NATO SfP/973559.

area of existence of superconductivity. However, as estimations show, theshunt from a normal metal, by virtue of existence of the law of Videmane-Frants, does not improve the effectiveness of work.

D2.1-04
Microwave controlled Josephson junctions
Devyatov, Igor, Russia
Brinkman, Alexandr, The Netherlands
Golubov, Alexandr, The Netherlands
Kupriyanov, Mikhail, Russia

The possibility of modulating an SNS Josephson junction critical current by nonequilibrium effects in the normal metal film caused by microwave irradiation are studied theoretically in the frame of microscopic theory. It is supposed that the structure has a four terminal cross geometry with two normal and two superconducting electrodes. It is shown that a flow of microwave current across the normal terminals essentially modifies the form of the electron energy distribution function in the N filmmaking it non-Fermi like. This results in variations of the critical current Ic of the structure, perpendicular to microwave current direction. The dependencies of Ic upon signal amplitude and frequency are calculated numerically. The possibility of using this structure for detection of microwave irradiation is discussed.

D2.1-05
Fast Pulsed Device for Large Critical Current Measurements
D'Ovidio, Claudio Alberto, Argentina
Malachevsky, Maria Teresa, Argentina

We describe an equipment for the measurement of pulsed transport critical currents in superconducting materials having a critical current of tens or hundreds of amperes. It is based on the appliance of an electrical current for a very short period of time, rapid enough to preserve the integrity of the current leads and minimize Joule effect. Power is applied to the wire-sample ensemble and the voltage drop is measured within seconds, with a resolution of the order of 10 nV. The hardware is composed of three parts: the current pulse generator, a low noise-quick response voltage amplifier and a PC with a DAC-ADC card. The data acquisition is achieved via an Assembler program.

D2.1-06
Software package for magnetic field, currents and inductance calculation
Khapaev, Mikhail, Russia
Khapaev, Mikhail, Russia
Kupriyanov, Mikhail, Russia

Recently software package 3D-MLSI was developed for inductance calculation in multilayer superconducting integrated circuits. The key advantages of 3D-MLSI are: new mathematical model that takes into account 3D distribution of magnetic field, user interface compatible with the Cadence and ACAD design tools. The program is the most applicable in case of technology when both kinetic and magnetic inductances are important. The new version of the programinclude improved current visualization, effective inductance calculation for holes containing zero fluxoids and automaticgeneration of all possible terminal-to-terminal inductances for the layout. In the last case the output is compatible with circuit simulators. It is also possible to calculate currents induced by external magnetic field. The results for transformers and currents in sheets with holes are presented.

D2.1-07
Dynamics of some pi - junction interferometers
Kornev, Victor, Russia
Pedersen, Niels, Denmark
Arzumanov, Alexey, Russia
Mozhaev, Peter, Russia
Shcherbakov, Nikita, Russia

The pi-junction superconducting circuit dynamics was studied by means of numerical simulation technique. Special attention was paid to the dynamics of superconducting quantum interferometers, containing the pi-junctions, which can act as phase "qubits" – the basic elements of a quantum computer. Experimental results for dc HTS interferometer, containing "0" and "p/2" junctions, are reported and discussed.
Parallel arrays consisting of Josephson junctions of both "0" and "p" type were also studied numerically, the results were compared with the experimental I-V curves for bicrystal high-Tc Josephson junctions. The array dynamics and I-V characteristics are discussed.

The work was supported in part by INTAS Program of EU, NATO for peace Program.

D2.1-08
HTS scanning SQUID microscope with high spatial resolution for room temperature samples
Gudoshnikov, Sergey, Russia
Deryuzhkina, Yuliya, Russia
Liubimov, Boris, Russia
Matveets, Liudmila, Russia
Rudenchik, Pavel, Russia
Snigirev, Oleg, Russia
Kalabukhov, Alexey, Russia
Ranchinski, Mikhail, Russia
Seidel, Paul, Germany

A HTS scanning SQUID microscope for imaging samples at room temperature and atmospheric pressure has been developed. A HTS SQUID combined with a flux-guide made of soft magnetic material is used as a sensor that allows magnetic imaging of warm samples with spatial resolution close to 100 micrometers. Magnetic images of a test current coil and simple magnetic structure measured by the developed microscope and by a high-resolution microscope with liquid-nitrogen cooled sample, having a bare SQUID as a sensor, are compared with results of a numerical modeling. The influence of the flux-guide on the image details has been studied.

D2.1-09
Different multilayer configurations in light-sensitive tunnel junctions
Monaco, Antonia, Italy
Granata, Carmine, Italy
Russo, Maurizio, Italy

Ligth-sensitive semiconducting films as barrier are a feasible tool to modify the tunneling behavior of superconducting junctions during the experiments. II-VI compounds have been demonstrated to be suitable to such a purpose, their fabrication procedure being compatible with all refractory Josephson junction technology.
Experiments performed on light-sensitive Josephson tunnel junctions have shown the relevant rôle of the metal/semiconductor interfaces in determining their transport properties. Different kind of all refractory Nb/Nb junctions have been fabricated involving CdS thin film in a sandwich-type structure. Semiconducting layer with a thickness up to

POSTER SESSION D.1

LTS and HTS junctions and circuits 1

August 27th, 2001, 16:15-18:00

D1.1-02

Influence of thermal cycling on Tow Level Fluctuation observed in epitaxial NbN/MgO/NbN tunnel junctions

HAMASAKI, Katuyosi, Japan
Ishida, Hiroki, Japan
Kawakami, Akira, Japan
Saito, Atusi, Japan

We have investigated the influence of thermal cycling on Tow Level Fluctuation (TLF) observed in NbN/NgO/NbN superconductor-insulator-superconductor tunnel junctions epitaxially grown on MgO(100) single crystals. The measured power spectral density Sv(f) had a Lorentzian frequency dependence as expected from the Machlup formula for random telegraph noise. These spectra disappeared and appeared during the repeated thermal cycling between 300 and 4.2 K. The applied voltage dependence of the Lorentzian corner frequency for NbN/MgO/NbN junctions were was explained by thermal activation model. As pointed by Weesley et al., pure MgO barriers are oxygen deficient and easily adsorb hydroxide. These defects and hydroxide generally act as a 1/f noise source in NbN/MgO/NbN junctions. The results on thermal cycling for NbN/MgO/NbN unctions, however, indicate that the TLF source in these epitaxial tunnel junctions is stress induced in a thin film during thermal cycling because of the difference in the thermal-expansion coefficients for the film and the substrate.

D1.1-03

Double-barrier Josephson junctions with high critical parameters

Nevirkovets, Ivan, USA
Ketterson, John, USA

At present, technical realization of the superconducting digital circuits demands overdamped Josephson junctions with a moderate critical current density, j_c, of order 20 kA/cm^2. Among the candidates (SNS, SIS, and SINIS junctions) suitable for this practically important j_c region, the SINIS junctions seem to be most promising (here S, I, and N denote superconductor, insulator, and normal metal, respectively). However, the SINIS junctions fabricated so far using the Nb/Al technology, demonstrated too low (~0.3 mV) critical voltage. In this work, it is shown that asymmetric SINIS junctions with different transparency of the two tunnel barriers may have higher critical voltages than analogous symmetric junctions at 4.2 K. Also, the double-barrier junctions with a complex (NS'N) interlayer were fabricatedand investigated for the first time. If the thickness of the S' layer is very thin, the SINS'NIS junctions have quasiparticle current-voltage characteristics similar to those of conventional SINIS junctions at 4.2 K, but the Josephson critical current densities, and therefore, the critical voltages, are much higher than the corresponding values for the SINIS junctions.

D1.1-06

Pulsed-assisted escape from zero voltage state in Josephson systems.

Rotoli, Giacomo, Italy
De Leo, Cinzia, Italy
Pepe, Giovanni Piero, Italy
Barone, Antonio, Italy
Peluso, Geppino, Italy
Parlato, Loredana, Italy

The behavior of a Josephson system under pulsed operation is of utmost importance for developing reliable digital devices workingat very high clock frequencies. Information about effect of thermal noise over pulsed operation is also useful to designerrors free devices.
Recent experiments in a system of two stacked junctions [1] show that a pulsed operation on the first junction (injector) of the stack drive the Josephson biased second junction (detector) into theresistive state. The experiment was interpreted as pulsed-assisted escape toward resistive state as a consequence of an excitation of non-linear oscillations in the detector junction that, with thecontribution of thermal noise, drives out the junction from the zero voltage state. Moreover, in the same experiment foran unstability of the resistive state toward the zero voltage state under the pulsed operation was also noted.
By means of a systematic numerical approach to the problem, we present a study of the pulsed-assisted escape using the framework of the thermal escape theory for both direct transition from zero voltage state to resistive state, and the return transition from resistive to zero voltage. We study the single junction case, both small and long, and the stacked junctions case as examples of three different systems showing pulsed-assisted escape.

[1] G.P.Pepe et al., Pulse-induced switches in a Josephson tunnel stacked device, submitted to Appl.Phys.Lett. March 2001.

D1.1-07

Physics of double-barrier Josephson junctions

Brinkman, Alexander, The Netherlands
Golubov, Alexander, The Netherlands
Rogalla, Horst, The Netherlands
Wilhelm, Frank, The Netherlands
Kupriyanov, Mikhail, Russia

New theoretical results on double-barrier SIS'IS Josephson junctions are presented (I is a tunnel barrier, S' is a superconducting thin film with critical temperature lower than that of S). The general solution of the microscopic equations that describe the electronic transport through double-barrier Josephson junctions is studied. The interplay between Andreev- and transmission-resonances describes the crossover from phase coherent transport to a regime where coherence is lost. This results in a specific dependence of the Josephson supercurrent on temperature and barrier strength, which agrees well with available experimental data. The microscopic model for the stationary case is extended to the non-equilibrium regime of finite voltages by means of the Keldysh formalism, in order to explain current-voltage data.

D1.1-10

Current-phase relationship of Nb/InAs/InAs(2DEG)/InAs/Nb Josephson junctions

Il'ichev, Evgeni, Germany
Grajcar, Miroslav, Germany
Ebel, Mark, Germany
Kuersten, Reinhard, Germany
Matsuyama, Toru, Germany
Merkt, Ulrich, Germany
Meyer, Hans-Georg, Germany

We have measured the current-phase relationship (CPR) ofNb/InAs-InAs(2DEG)-InAs/Nb Josephson junctions with highlytransparent interfaces. The Nb electrodes defined by e-beamlithography are weakly coupled by the two-dimensional electron gas(2DEG) that forms at the surface of p-type InAs single crystals.

PLENARY SESSION A

August 27th, 2001, 09:15-10:00

A-01

LARGE SCALE SUPERCONDUCTING MAGNETS FOR PHYSICS RESEARCH

ten Kate, Herman, Switzerland

Research and development of large scale superconducting magnets and requirements for physics research often go hand in hand. Good examples are accelerators and detectors for high energy physics, confinement of nuclear plasma in reactors and high field nuclear magnetic resonance. The current status of magnet design and realization of present large scale projects is reviewed. The development of practical superconductors for such magnets is presented. There is a continuos effort to improve the understanding of high-current cabled conductors and the impact of cable properties on stability, quench behavior and field quality. Further development of in particular NbSn conductors in terms of current density and filament size may lead to feasible application in future accelerators. Finally the prospects of BSCCO/Ag-alloy conductors for use in large scale magnets is addressed.

ORAL SESSION A1

LTS Junctions and circuits

August 27th, 2001, 10:30-12:00

A1-01

Engineering Issues in High-Frequency RSFQ Circuits

Van Duzer, Theodore, USA
Meng, Xiaofan, USA
Yu, Lei, USA
Newman, Nathan, USA
Loyo, Carlos, USA
Rowell, John, USA
Whiteley, S.R., USA
Zheng, L., USA
Yoshikawa, N., Japan

We report research on Josephson junctions with TaN barriers and high IcRn values as drop-in replacements for the tunnel junctions now in use in the niobium RSFQ logic family. Complex circuits made with the now-standard Nb/AlOx/Nb tunnel junction technology are burdened with the need to resistively shunt the junctions in order to obtain the required nonhysteretic I-V characteristics. The shunt resistors consume space and introduce parasitic inductances. Several approaches have been suggested for internally shunted junctions, including raising the current densities of tunnel junctions to very high values or the use of SINIS or SNS junctions. In order to be useful for high logic speeds, the junctions must have IcRn values above 0.5 mV, sufficiently small statistical spreads of Ic, and little variation of Ic with temperature (say, from 4.2 K to 5 K).

We previously demonstrated SNS (NbN/TaN/NbN) junctions formed on MgO substrates with high IcRn products, some higher than 1 mV. We are adapting to the requirement of Nb electrodes and Si substrates, and have replaced NbN by NbTiN, which has a slightly higher Tc and other advantageous properties. The junction structure is now a pentalayer, Nb/NbTiN/TaN/NbTiN/Nb, which can be adopted as a drop-in replacement for the shunted tunnel junction. In preliminary evaluations, we have found IcRn values above 2 mV. We report on junctions made with a variety of barrier thicknesses and resistivities, as well as analyses of the barriers using structural, optical, microprobe, and ion-beam characterization.

A1-02

Transport properties of double barrier Nb-based Josephson junctions

Siegel, Michael, Germany
Cassel, Diego, Germany
Brinkman, Alexander, The Netherlands
Golubov, Alexander, The Netherlands
Kuprianov, Mikhail, Russia
Rogalla, Horst, The Netherlands

The transparency of the tunnel barriers in double-barrier junctions influences the critical current density and the form of the current-voltage characteristics. We have performed a systematic study of the influence of the barrier transparency on critical current and normal resistance by preparing SIS and SINIS junctions based on Nb/Al oxide technology under identical technological conditions and comparing their transport properties. We have fabricated Nb/Al-Oxid/Al/Al-Oxid/Nb devices with different current densities using a conventional fabrication process, varying pressure and oxidation time. Patterning of the multilayers was done using conventional photolithography and the selective niobium etching process. The current density of SIS junctions was changed in the range from 0.5 to 10 kA/sqcm. At the same conditions the current density of SINIS devices revealed 10 to 1000 A/sqcm with non-hysteretic current-voltage characteristics and characteristic voltages of 300 μV. By comparing the experimental and theoretical temperature dependence of the characteristic voltage we estimated the barrier transparency and its asymmetry. The comparison shows a good agreement of experimental data with the theoretical model of tunneling through double-barrier structures in the dirty limit.

A1-03

Properties of SNS Josephson junctions with HfTi interlayers

Hagedorn, Daniel, Germany
Buchholz, F.-Im.
Niemeyer, Jürgen, Germany
Dolata, Ralf

In low-temperature superconducting electronics to be used in highly integrated circuits, increasing activities are observed in using Josephson junctions with internal shunts as active circuit elements. Within the complex heterostructure of these junctions the role of the interfaces between different materials has been studied. At PTB, we fabricated superconductor-normal metal-superconductor (SNS) ramp-type Josephson junctions with dimensions down to the deep sub-micron range. Typical values of the critical current density and the characteristic voltage are jC = 470 kA/cm2 and VC = 100 μV for Nb/HfTi/Nb junctions and jC = 115 kA/cm2 and VC = 360 μV for Nb/HfTi/Nb/HfTi/Nb multilayer junctions, each for areas of A = 0.2 μm2. Experiments on single junctions and junction arrays were carried out to study the temperature dependence of critical currents, the influence of externally applied magnetic fields, and the application of microwave power. The measurement results will be presented and compared with theory.

Work supported by the European Union (SMT4-CT98-2239), the Bundesministerium für Bildung und Forschung (BMBF), Germany (13N6835, 13N7259, 13N7494) and the Deutsche Forschungsgemeinschaft (DFG), Germany (NI 253/3-1/3-2).