The figure schematically depicts a typical measurement setup to which the technique is applied. The additional hardware includes an isothermal block (made of copper) instrumented with a reference thermocouple and a compensation thermocouple. The reference thermocouple is connected to an external data-acquisition system (DAS) through a two-pin thermocouple-alloy hermetic feedthrough connector, but this is the only such connector in the apparatus. The compensation thermocouple is connected to the DAS through two pins of the same ordinary multipin connector that connects the measurement thermocouples to the DAS.

It is assumed that all the pins in the ordinary connector, including those for the compensation thermocouple, are subjected to the same temperature gradient. To ensure this, the extension wires of the compensation thermocouple must be routed close to those of the measurement thermocouple for distance on the order of a meter on both sides of the bulkhead and connector.

The thermal-EMF error manifests itself as an offset potential, V_O, having the same value in all the thermocouple channels passing through the ordinary connector. Hence, the offset potential is present in the compensation-thermocouple channel. However, the offset potential is not present in the reference-thermocouple channel because this channel contains the thermocouple-alloy connector. Because the compensation and reference thermocouples are at the same temperature (the temperature of the isothermal block), the offset potential can be found through subtraction of the voltages in the compensation and reference channels:

$$V_O = V_B - V_R$$

where V_B is the uncorrected voltage in the compensation channel and V_R is the voltage in the reference channel. It is worthwhile to note that although these thermocouple voltage readings from the block are used to calculate V_O, the block temperature need not be known explicitly; hence, no attempt is made to determine it.

The DAS software performs the thermal-EMF correction by simply subtracting the offset potential from the voltage in each measurement-thermocouple channel. The corrected voltage is then used to calculate the temperature of the thermocouple in the standard manner, by use of a voltage-to-temperature conversion polynomial for the particular thermocouple type and reference junction temperature.

This work was done by Robert A. Ziemke of **Glenn Research Center**. *Further information is contained in a TSP (see page 1).*

Inquiries concerning rights for the commercial use of this invention should be addressed to NASA Glenn Research Center, Commercial Technology Office, Attn: Steve Fedor, Mail Stop 4-8, 21000 Brookpark Road, Cleveland, Ohio 44135. Refer to LEW-17491-1.

Using Quasiparticle Poisoning To Detect Photons

A mesoscale quantum phenomenon would be exploited to obtain high sensitivity.

NASA's Jet Propulsion Laboratory, Pasadena, California

According to a proposal, a phenomenon associated with excitation of quasiparticles in certain superconducting quantum devices would be exploited as a means of detecting photons with exquisite sensitivity. The phenomenon could also be exploited to perform medium-resolution spectroscopy. The proposal was inspired by the observation that Coulomb blockade devices upon which some quantum logic gates are based are extremely sensitive to quasiparticles excited above the superconducting gaps in their leads. The presence of quasiparticles in the leads can be easily detected via the charge states. If quasiparticles could be generated in the leads by absorption of photons, then the devices could be used as very sensitive detectors of electromagnetic radiation over the spectral range from x-rays to submillimeter waves.

The devices in question are single-Cooper-pair boxes (SCBs), which are mesoscopic superconducting devices developed for quantum computing. An SCB consists of a small superconducting island connected to a reservoir via a small tunnel junction and connected to a voltage source through a gate capacitor. An SCB is an artificial two-level quantum system, the Hamiltonian of which can be controlled by the gate voltage. One measures the expected value of the charge of the eigenvectors of this quantum system by use of a radio-frequency single-electron transistor. A plot of this expected value of charge as a function of gate voltage resembles a staircase that, in the ideal case, consists of steps of height 2 e (where e is the charge of one electron).

Experiments have shown that depending on the parameters of the device, quasiparticles in the form of "broken" Cooper pairs present in the reservoir can tunnel to the island, giving rise to steps of 1 e. This effect is sometimes called "poisoning." Simulations have shown that an extremely small average number of quasiparticles can generate a 1-e periodic signal.

In a device according to the proposal, this poisoning would be turned to advantage. Depending on the wavelength, an antenna or other component would be used to couple radiation into the reservoir, wherein the absorption of photons would break Cooper pairs, thereby creating quasiparticles that, in turn, would tunnel to the island, creating a 1-e signal. On the basis of conservative estimates of device parameters derived from experimental data and computational simulations that fit the data, it has been estimated that the noise equivalent power of a device according to the proposal could be as low as 6×10^{-22} $W/Hz^{1/2}$. It has also been estimated that the spectroscopic resolution (photon energy ÷ increment of photon energy) of such a device in visible light would exceed 100.

This work was done by Pierre Echternach and Peter Day of Caltech for **NASA's Jet Propulsion Laboratory**. *Further information is contained in a TSP (see page 1).*
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