previously by Strum [1] and Colvin [2], for the system is then of the simple Dicke type.

If N antennas are directed in time sequence at the same region of the sky, the noise outputs of the channels are statistically independent when corrected for time shift, and an average of the N records gives a least detectable signal temperature of

$$T_{1d} = 2T_R\sqrt{\frac{\alpha}{\beta}\,\frac{N+1}{N}}$$

= least detectable equivalent signal temperature for all N channels.

Conclusions

It has been shown that a radiometer may be switched between several antennas with some loss in sensitivity. In radio astronomy, several applications for this type of system suggest themselves. If the ultimate sensitivity is not required for a particular measurement, the production of several observations with one receiver would reduce the data acquisition time. This technique is applicable if a paraboloidal antenna with a multiple feed system is employed. If, in addition, the feeds are such that the same region is observed with the several channels at different times, the results may be combined to produce a sensitivity which is slightly better than that of the simple Dicke system. This type of receiver could also be employed with a multiple beam array antenna.

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Mercury-Rare Gas Visible-UV Laser

In their listing of observed argon-ion laser lines Heard and Peterson[1] have repeated my incorrect assignment[2] for the line Ar II 4880 Å. The correct assignment, $4p^2D^\circ_{5/2} \rightarrow 4s^2P_{3/2}$, was called to my attention by Bennett, et al.,[3] and an *erratum* subsequently appeared.[4] However, it should also be corrected for the readers of the Proceedings.

Heard and Peterson also state that the blue-green Ar II lines have been operated quasi-CW (100–200 μ secs). True CW operation (hours) has previously been reported for the lines they list, and for five additional Ar II lines.[5]

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Manuscript received November 6, 1964.
[1] Heard, H. G. and J. Peterson, Mercury-rare gas visible-UV laser, *Proc. IEEE (Correspondence)*, vol 52, Sep 1964, pp 1049–1050.
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Author's Comment[6]

We acknowledge Bennett's correction[3] of the transition assignment for the 4880 Å Argon II and are indebted to W. B. Bridges for bringing this to our attention.

With respect to Bridges' comments on quasi-CW operation: at the time of publication CW operation had been reported, but only at the milliwatt level and only for Argon. Heard and Peterson[1] reported power outputs in excess of 10 watts with no noticeable saturation effect for argon and xenon for time durations which were limited only by the modulator. Since that time as much as a 7 watt peak has been obtained for single-line operation at 4765 Å, using techniques which do not require prism selection of wavelength.

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Use of Transient Measurements in Metal-Insulator-Semiconductor Structures to Determine Semiconductor Doping Densities

The variation of capacitance with bias in the metal-insulator-semiconductor (M-I-S) structure, shown schematically in Fig. 1, has been used to study the properties of surface states associated with the semiconductor-insulator interface [1]–[3]. Information about surface states can be obtained by comparing the calculated dependence of capacitance on bias with experimental results.

Manuscript received October 8, 1964; revised October 19, 1964. The research reported here was sponsored by the U. S. Army Electronic Labs., Fort Monmouth, N. J., under Contract DA28-043-AMC-00231(E) and RCA Labs., Princeton, N. J.

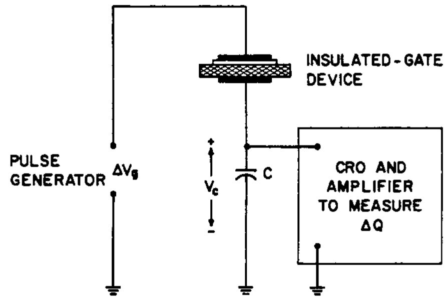

Fig. 1. Experimental method used for transient measurements.

However, it has been pointed out by Zaininger [3] that if the measurement is to be meaningful, one must accurately know the donor or acceptor density in the semiconductor. If the donor density is not known accurately, the above method will lead to errors in determining the surface-state density.

Knowledge of the doping density in a semiconductor used in insulated-gate devices [4], [5], is difficult to obtain by conventional means. Hall measurements on the semiconductor prior to completion of the device may be misleading since subsequent processing may affect the donor doping densities. This is particularly true in thin films. The same measurements are not convenient in completed structures and can be difficult to interpret due to variation of carrier density in the surface space-charge region [6]. It is the purpose of this correspondence to describe a technique for determining the doping density in a completed M-I-S device. The method used is similar to the one used by Many [7] in studying the Schottky barrier at a CdS-electrolyte contact. The experimental set-up is shown in Fig. 1. It consists of the device, a pulse generator, and a large capacitor to measure the charge induced into the M-I-S contact.

The theory of the measurement is as follows: assume that by applying a dc bias on the gate electrode, a depletion region is formed at the surface of the semiconductor. The charge in the depletion region can be expressed as

$$Q_D = \sqrt{2q\epsilon_s(N_D - N_A)}\;|\phi|^{1/2} \qquad (1)$$

where Q_D is the space charge in the depletion region per unit area, q is the electronic charge, N_D is the donor impurity, N_A is the acceptor impurity density, ϵ_s is the semiconductor permittivity, ϕ is the surface potential with the dc bias applied. The assumption of uniform donor and acceptor density in the space-charge region has been made. If now a narrow-voltage pulse is applied to the gate in a direction so as to further deplete the surface, all charge removed will come from the conduction band and not from surface or deep traps. This is true if the pulse is narrow enough so that surface states and deep traps are not in thermal equilibrium with the conduction band. The new charge in the depletion region is now

$$Q_D' = \sqrt{2q\epsilon_s(N_D - N_A)}\;|V_s|^{1/2} \qquad (2)$$

where V_s is the new surface potential. The analysis which follows is similar to the one