



# 1997年エレクトロニクスソサイエティ大会 講演論文集

### 一般講演

C-1. 電磁界理論

C-3. 光エレクトロニクス

C-2. マイクロ波 A. B. C. C-4. レーザ・量子エレクトロニクス

# シノボジウム

SC-1. マイクロ波、ミリ波帯における電磁波の人体影響と防護

SC-2. マイクロ波回路の電磁界解析における諸問題

SC-3. 光波ネットワーク用光デバス・光同路

SC-4.機能デバイスとしてみた半導体レーザ

## ソサイエティ企画

特別企画プルナリーセッション

パネル討論 PC-1. マイクロ波発振器における位相雑音の解析・測定・低減化技術

PC-2. ここまで来た光スイッチ

チュートリアル講演 TC-1. Si デンバイス MMIC の最近の技術動向

TC-2. 光導波路デバイスの展開

1997年9月3日~6日 早稲田大学理工学部キャンパス(東京都新宿区)

September 3~6, 1997, WASEDA UNIVERSITY, TOKYO, Japan

ELECTRONICS SOCIETY

THE INSTITUTE OF ELECTRONICS, INFORMATION AND COMMUNICATION ENGINEERS

程可電子情報通信学会 エレクトロニクスソサイエティ

(大会終了までは複写を禁止します. 大会終了後は目次の最終ページに記載の方法により複写できます.)

#### Plane Wave Diffraction by a Strip with Different Surface Impedances: Solution by the Analytical-Numerical Approach C - 1 - 16

Eldar I. Veliev<sup>1)</sup>, Kazuya Kobayashi<sup>2)</sup>, Masanori Ogata<sup>2)</sup>, and Shoichi Koshikawa<sup>3)</sup> 1) Institute of Radiophysics and Electronics, Ukrainian Academy of Sciences, Kharkov 310085, Ukraine 2) Department of Electrical and Electronic Engineering, Chuo University, Tokyo 112, Japan 3) Antenna Giken Co., Ltd., 4-72 Miyagayato, Omiya 330, Japan

The diffraction by strips with impedance-type boundary conditions is an important subject in the radar cross and impedance strips, the RCS is reduced for the case of section (RCS) reduction of targets. This structure serves as a suitable model of thin dielectric slabs and finite-length noticeable for x > 0. coatings. In [1, 2], we have analyzed the plane wave diffraction by an impedance strip using the analytical-numerical et al. [4] based on the use of the geometrical theory of approach [3], where the efficient solution has been obtained for the same surface impedances on both sides of the strip. As an important generalization to our previous analysis, the bistatic RCS is illustrated as a function of observation we shall consider in this paper a strip with different surface impedances and analyze the E-polarized plane wave diffraction by means of the analytical-numerical approach. The time factor is assumed to be  $e^{-i\omega t}$  and suppressed in the following analysis.

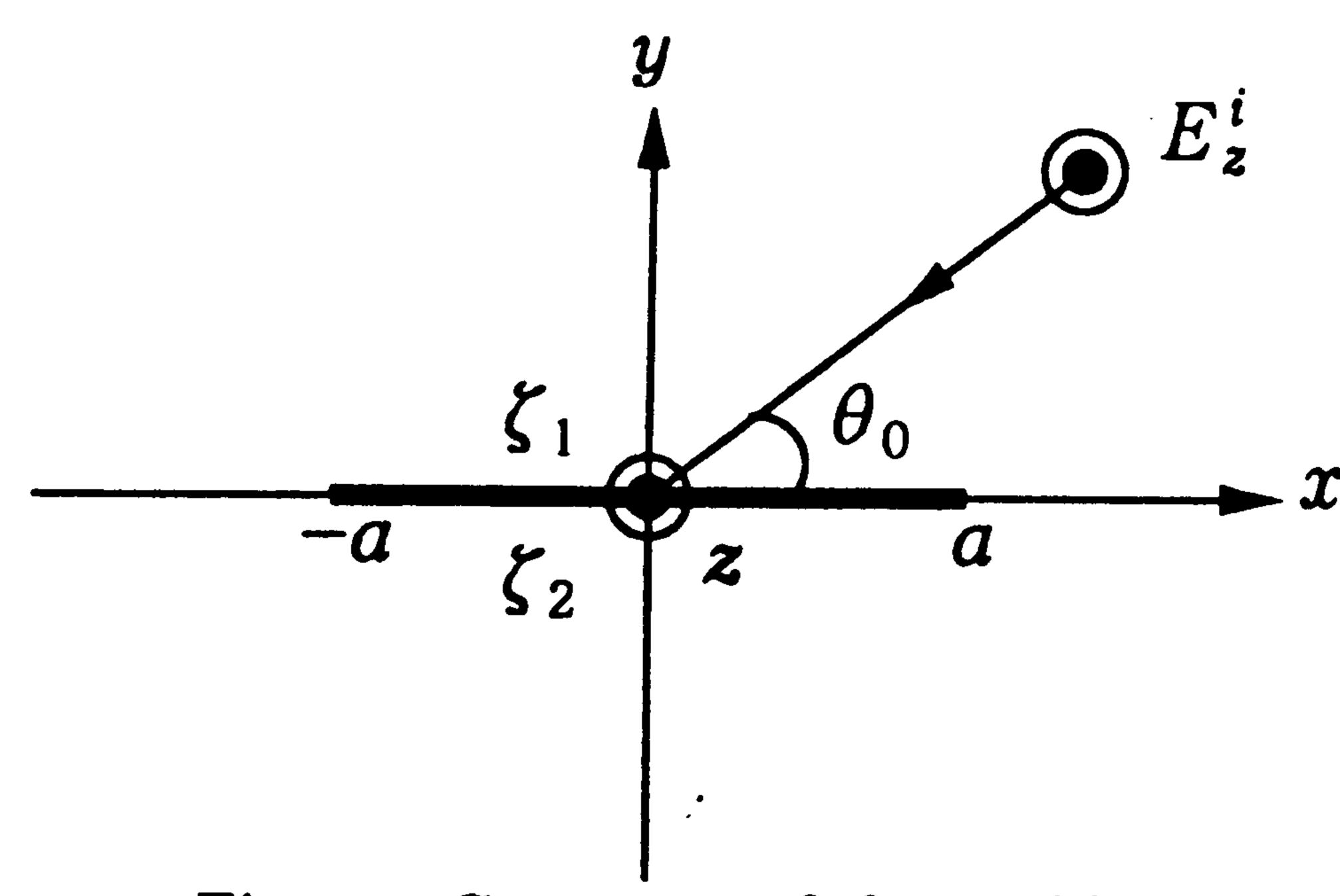


Fig. 1. Geometry of the problem.

The geometry of the impedance strip is shown in Fig. 1, where  $E_{\tau}^{i} = e^{-ik(x\cos\theta_0 + y\sin\theta_0)}$  is the incident plane wave with k being the free-space wavenumber. On the strip surface, the total electric field satisfies the boundary condition as given by

$$\frac{\partial E_z(x,\pm 0)}{\partial y} \pm \frac{ik}{\zeta_{1,2}} E_z(x,\pm 0) = 0, \quad |x| < a,$$

where  $\zeta_1$  and  $\zeta_2$  are the normalized impedances of the upper and lower surfaces of the strip, respectively. Applying the above boundary condition to an integral representation of the scattered field, the problem is formulated as two integral equations satisfied by the unknown current density functions. Expanding the current density functions in terms of the Gegenbauer polynomials, our problem is reduced to the solution of two infinite systems of linear algebraic equations (SLAE) satisfied by the unknown expansion coefficients. These coefficients are determined numerically with high accuracy via a truncation of the SLAE. Evaluating the scattered field asymptotically, a far field expression will be derived.

Figure 2 shows the bistatic RCS as a function of observation angle for  $\theta_0 = 60^{\circ}$ , ka = 5. In order to investigate the effect of the surface impedances on the far field scattering characteristics, three different cases have been considered as in  $(\zeta_1, \zeta_2) = (2, 1), (1, 1), (0, 0),$  where  $\zeta_{1,2} = 0$ corresponds to a perfectly conducting strip. Comparing the

scattering characteristics between the perfectly conducting the impedance strip as expected. The RCS reduction is

This problem has previously been analyzed by Tiberio diffraction (GTD) together with the Maliuzhinetz method. Shown in Fig. 3 is a comparison with their results, where angle for  $\theta_0 = 180^\circ$ , ka = 10,  $\zeta_1 = 4$ ,  $\zeta_2 = 0$ . It is seen from the figure that our RCS results are in good agreement with the results presented in [4].

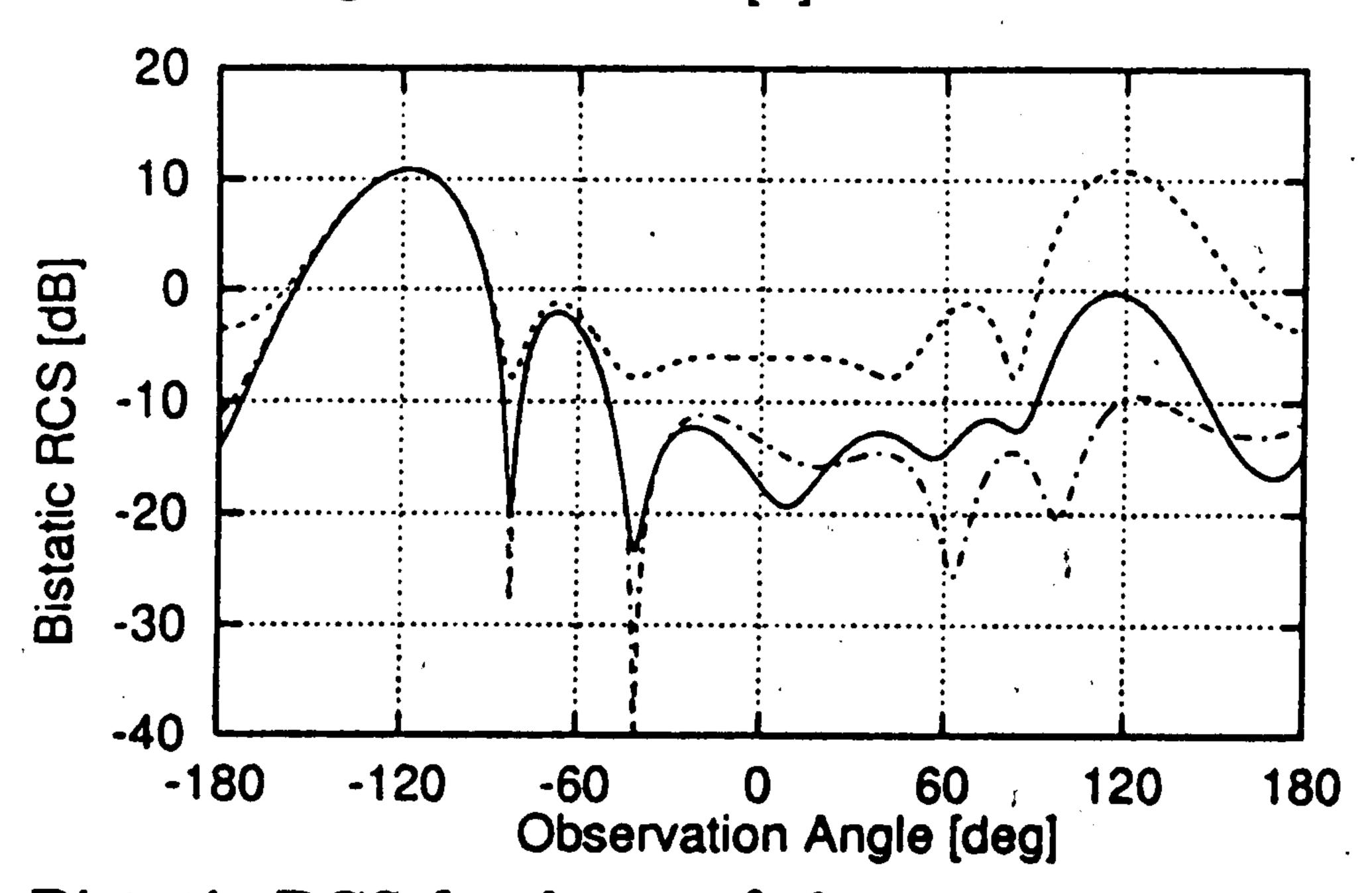


Fig. 2. Bistatic RCS for  $\theta_0 = 60^{\circ}$ , ka = 5. ——:  $\zeta_1 = 2$ ,  $\zeta_2 =$ 1;  $-\cdot - \cdot - : \zeta_1 = \zeta_2 = 1; \cdots : \zeta_1 = \zeta_2 = 0.$ 

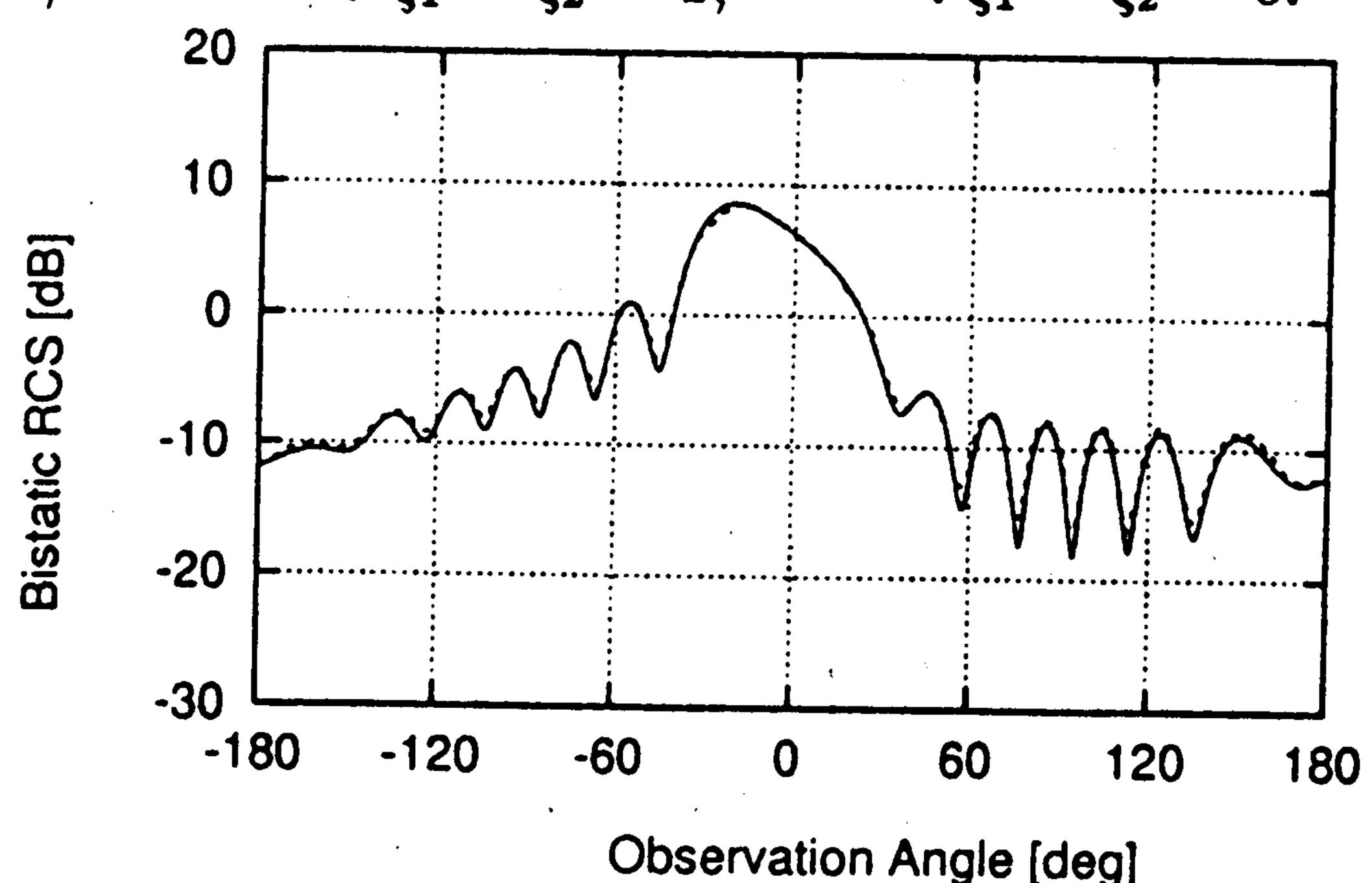


Fig. 3. Bistatic RCS for  $\theta_0 = 180^{\circ}$ , ka = 10,  $\zeta_1 = 4$ ,  $\zeta_2 = 0$  and its comparison with Tiberio et al. [4]. ——: this paper; ····: Tiberio et al. [4].

#### Acknowledgments

This work was supported in part by the 1997 Chuo University Special Research Grant and by the Institute of Science and Engineering, Chuo University.

#### References

[1] E. I. Veliev, K. Kobayashi, T. Ikiz, and S. Koshikawa, Paper presented at 1996 International Symposium on Antennas and Propagation, September 24-27, 1996, Chiba, Japan. [2] E. I. Veliev, K. Kobayashi, and S. Koshikawa, Paper presented at 1996 Korea-Japan Joint Conference on Electromagnetic Theory and Compatibility, August 1-3, 1996, Seoul, Korea. [3] E. I. Veliev and V. V. Veremey, Analytical and Numerical Methods in Electromagnetic Wave Theory, Chap. 10, M. Hashimoto, M. Idemen, O. A. Tretyakov, Eds., Science House, Tokyo, 1993. [4] R. Tiberio, F. Bessi, G. Manara, and G. Pelosi, Radio Sci., Vol. 17, No. 5, pp. 1199-1210, 1982.