Abstract: In this paper, we present a review on edge excited rays on convex and concave perfectly conducting structures with sharp edges or curvature discontinuities. The incident wave is either a space wave, a creeping wave or a whispering gallery wave. The observation point may be at large distance from the structure or located on its surface. In addition to more classical formulas, the paper contains also some new solutions established by the author.

1. EDGE TYPE SINGULARITY IN A CONVEX SURFACE
Formulas for edge excited creeping waves by an incident space wave or a creeping wave with emission of a space wave at large distance, which are known as hybrid diffraction coefficients, have been derived by Pathak and Koujoumjian [1], Albertsen [2], Molinet [3], Albertsen and Christiansen [4]. They have been extended to curved edges in a 3D surface by Hill and Pathak [5]. A uniform solution valid at grazing incidence has been derived by Liang [6]. Michaeli [7] obtained an asymptotic expansion of the solution established by Idemen and Felsen [8] for the canonical diffraction problem of a plane wave by a truncated cylindrical shell which he extended to the wedge problem at grazing incidence. He showed that the field in the transition region is described by new Fock functions involving incomplete Airy functions. A three-dimensional version of Michaeli’s uniform solution, valid at grazing incidence has been established by Molinet [9]. When the observation point is located on the surface, or reciprocally when the source is located on the surface, the Fock functions which are involved in the former solutions are replaced by Nicholson’s functions. At grazing incidence new transition functions have been established by Michaeli [10]. The field on the surface or the corresponding asymptotic currents have been compared on 2D geometries with the Method of Moments results and an excellent agreement has been obtained [11].

2. CURVATURE DISCONTINUITY IN A CONVEX SURFACE
The asymptotic theory of diffraction by a discontinuity in curvature on a smooth convex perfectly conducting surface was initially restricted to situations where both the incident and the diffracted rays were bound to make sufficiently wide angles with the tangent plane at the point of diffraction on the discontinuity [12] [13] [14]. More recently, the theory has been extended by Michaeli [15] to cover the case where one of the two rays is nearly tangent to the surface or represents a creeping ray. A further augmentation of the theory has been established by Michaeli and Molinet [16] who extended the solution to the case where both rays are now permitted to be nearly tangent to the surface or represent a creeping ray, provided both of them are situated on the same side of the discontinuity in question. This situation excludes forward scattering, but includes back scattering.

Recently, Michaeli’s procedure for grazing incidence on a curved convex wedge has been extended by Molinet [17] to a curvature discontinuity and gives the creeping wave excited at grazing incidence in forward scattering. The same approach gives also the field on the surface for gazing incidence.

3. EDGE TYPE SINGULARITY IN A CONCAVE SURFACE
The formulas for the diffraction of a Whispering Gallery Mode by the edge of a thin cylindrically curved surface have been established by Idemen and Felsen [8] using the solution of the canonical problem of the curved shell obtained by the same authors and the Green’s function of a line source located on a concave cylindrical surface established earlier by Ishihara, Felsen and Green [18]. Later on Idemen [19] established modal edge diffraction coefficients and Idemen and Büyükkaksy [20] obtained formulas for surface currents induced by a line source located near either the convex or the concave side of a cylindrical reflector. An interesting expression has been obtained in [8] and [20] for the sum of the currents excited on both faces in a thin cylindrical shell: the variation of the sum with respect to the position is given by the incomplete Gamma function.

Starting with the integral form of the Green’s function established in [18] and [22] and performing a spectral decomposition of the field radiated by a line source in front of a concave surface, in the vicinity of the edge, new formulas for the diffraction coefficients of edge excited whispering gallery waves have been obtained by Molinet [23].
4. CONCAVE-CONVEX SURFACE WITH A CURVATURE DISCONTINUITY OR AN INFLECTION LINE

The procedure described in section 3 has also been extended to the diffraction of a whispering gallery wave by a discontinuity in curvature on a concave surface or a concave-convex surface. An approximate solution has also been established by Molinet [22, 23] for a convex-concave 2D surface with an inflection line. The solution gives the current on the concave surface excited by the diffraction of a plane wave by an edge in the form of a whispering gallery wave represented by a Fock-type integral. In the vicinity of the inflection line, the latter is expended in a spectrum of inhomogeneous plane waves. At first order, this spectrum is not modified when the observation point passes through the inflection line, since in the vicinity of this point, the surface is quasi flat. This approximation enabled us to reduce the problem to the diffraction of a plane wave by a convex surface by applying the Spectral Theory of Diffraction and to solve the problem of mode conversion at the inflection point. The results obtained for the surface currents have been compared to a Method of Moments solution and an excellent agreement has been obtained [22, 23]. The behavior of the solution close to the inflection point has been investigated by Popov [24] and Smyshlyaev [25]. Popov showed that the field in the vicinity of the inflection line verifies a Schrödinger type equation. Goto and Ishihara [26] have solved numerically the Schrödinger equation by a finite difference algorithm in order to calculate the radiated field.

Recently an analysis of the radiated field using modal rays and their propagation by reflection on the surface through the inflection line, completed by modal and ray caustics corrections, has been performed by Goto, Ishihara and Felsen [27].

5. CONCLUSION

The formulas which have been established so far for edge excited rays on convex and concave perfectly conducting surfaces, permit to solve most of the problems encountered in high-frequency diffraction by objects composed of smooth curved surfaces connected together by line singularities. Some of these formulas have also been extended to coated surfaces.

REFERENCES