DOWNLOAD PDF PROPAGATION OF STRONG BLAST IN AN ATMOSPHERE OF VARYING DENSITY

Chapter 1 : Magnetogasdynamic Shock Waves in a Rotating Gas with Exponentially Varying Density

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Direct modes line-of-sight [edit] Line-of-sight refers to radio waves which travel directly in a line from the transmitting antenna to the receiving antenna. It does not necessarily require a cleared sight path; at lower frequencies radio waves can pass through buildings, foliage and other obstructions. This is the most common propagation mode at VHF and above, and the only possible mode at microwave frequencies and above. This is the method used by cell phones , cordless phones , walkie-talkies , wireless networks , point-to-point microwave radio relay links, FM and television broadcasting and radar. Ground plane reflection effects are an important factor in VHF line of sight propagation. Surface modes groundwave [edit] Main article: In this mode the radio wave propagates by interacting with the conductive surface of the Earth. The wave "clings" to the surface and thus follows the curvature of the Earth, so groundwaves can travel over mountains and beyond the horizon. Ground waves propagate in vertical polarization so vertical antennas monopoles are required. Attenuation is proportional to frequency, so ground waves are the main mode of propagation at lower frequencies, in the MF , LF and VLF bands. Ground waves are used by radio broadcasting stations in the MF and LF bands, and for time signals and radio navigation systems. These frequencies are used for secure military communications. They can also penetrate to a significant depth into seawater, and so are used for one-way military communication to submerged submarines. Early long distance radio communication wireless telegraphy before the mids used low frequencies in the longwave bands and relied exclusively on ground-wave propagation. The discovery around of the ionospheric reflection or skywave mechanism made the medium wave and short wave frequencies useful for long distance communication and they were allocated to commercial and military users. Skywave Skywave propagation, also referred to as skip , is any of the modes that rely on reflection actually refraction of radio waves from the ionosphere. A radio wave directed at an angle into the sky can be reflected back to Earth beyond the horizon by these layers, allowing long distance radio transmission. The F2 layer is the most important ionospheric layer for long-distance, multiple-hop HF propagation, though F1, E, and D-layers also play significant roles. The layers, or more appropriately "regions", are directly affected by the sun on a daily diurnal cycle , a seasonal cycle and the year sunspot cycle and determine the utility of these modes. Although the claim is commonly made that two-way HF propagation along a given path is reciprocal, that is, if the signal from location A reaches location B at a good strength, the signal from location B will be similar at station A because the same path is traversed in both directions. However, the ionosphere is far too complex and constantly changing to support the reciprocity theorem. The path is never exactly the same in both directions. Forecasting of skywave modes is of considerable interest to amateur radio operators and commercial marine and aircraft communications, and also to shortwave broadcasters. Real-time propagation can be assessed by listening for transmissions from specific beacon transmitters. Meteor scattering[edit] Meteor scattering relies on reflecting radio waves off the intensely ionized columns of air generated by meteors. Backscatter is angle-sensitiveâ€"incident ray vs. Random motions of electrons spiraling around the field lines create a Doppler-spread that broadens the spectra of the emission to more or less noise-likeâ€"depending on how high radio frequency is used. The radio-auroras are observed mostly at high latitudes and rarely extend down to middle latitudes. The occurrence of radio-auroras depends on solar activity flares , coronal holes , CMEs and annually the events are more numerous during solar cycle maxima. Radio aurora includes the so-called afternoon radio aurora which produces stronger but more distorted signals and after the Harang-minima, the late-night radio aurora sub-storming phase returns with variable signal strength and lesser doppler spread. Rarely, a strong radio-aurora is followed by Auroral-E, which resembles both propagation types in some ways. Sporadic-E at mid-latitudes occurs mostly during summer season, from May to August in the northern hemisphere and from November to February in the southern hemisphere. There is no single cause for this mysterious propagation mode. The ionisation patches drift westwards at speeds of few hundred km per hour. There is a weak periodicity noted during the season and typically Es is observed on 1 to 3 successive days and remains absent for a few days to reoccur again. Es do not occur during small hours; the events usually begin at dawn, and there is a peak in the afternoon and a second peak in the evening. Observation of radio propagation beacons operating around The peak-phase includes oscillation of MOF with periodicity of approximately The signals are very strong but also with slow deep fading. The inversion layer is mostly observed over high pressure regions, but there are several tropospheric weather conditions which create these randomly occurring propagation modes. Higher frequencies experience the most dramatic increase of signal strengths, while on low-VHF and HF the effect is negligible. Propagation path attenuation may be below free-space loss. Some of the lesser inversion types related to warm ground and cooler air moisture content occur regularly at certain times of the year and time of day. Tropospheric scattering troposcatter [edit] Main article: Tropospheric scattering At VHF and higher frequencies, small variations turbulence in the density of the atmosphere at a height of around 6 miles 9. In tropospheric scatter troposcatter communication systems a powerful beam of microwaves is aimed above the horizon, and a high gain antenna over the horizon aimed at the section of the troposphere though which the beam passes receives the tiny scattered signal. This mode scatters signals mostly forwards and backwards when using horizontal polarization and side-scattering with vertical polarization. Scattering from snowflakes and ice pellets also occurs, but scattering from ice without watery surface is less effective. The most common application for this phenomenon is microwave rain radar, but rain scatter propagation can be a nuisance causing unwanted signals to intermittently propagate where they are not anticipated or desired. Similar reflections may also occur from insects though at lower altitudes and shorter range. Rain also causes attenuation of point-to-point and satellite microwave links. The most common back-scatter applications are air-traffic radar, bistatic forward-scatter guided-missile and airplane-detecting trip-wire radar, and the US space radar. The hot lightning channel scatters radio-waves for a fraction of a second. The RF noise burst from the lightning makes the initial part of the open channel unusable and the ionization disappears quickly because of recombination at low altitude and high atmospheric pressure. Although the hot lightning channel is briefly observable with microwave radar, no practical use for this mode has been found in communications. Diffraction[edit] Knife-edge diffraction is the propagation mode where radio waves are bent around sharp edges. For example, this mode is used to send radio signals over a mountain range when a line-of-sight path is not available. However, the angle cannot be too sharp or the signal will not diffract. The diffraction mode requires increased signal strength, so higher power or better antennas will be needed than for an equivalent line-of-sight path. Diffraction depends on the relationship between the wavelength and the size of the obstacle. In other words, the size of the obstacle in wavelengths. Lower frequencies diffract around large smooth obstacles such as hills more easily. For example, in many cases where VHF or higher frequency communication is not possible due to shadowing by a hill, it is still possible to communicate using the upper part of the HF band where the surface wave is of little use. Diffraction phenomena by small obstacles are also important at high frequencies. Signals for urban cellular telephony tend to be dominated by ground-plane effects as they travel over the rooftops of the urban environment. They then diffract over roof edges into the street, where multipath propagation , absorption and diffraction phenomena dominate. Absorption[edit] Low-frequency radio waves travel easily through brick and stone and VLF even penetrates sea-water. As the frequency rises, absorption effects become more important. At microwave or higher frequencies, absorption by molecular resonances in the atmosphere mostly from water, H2O and oxygen, O2 is a major factor in radio propagation. This phenomenon was first discovered during radar research in World War II. Heavy rain and falling snow also affect microwave absorption. Measuring HF propagation[edit] HF propagation conditions can be simulated using radio propagation models , such as the Voice of America Coverage Analysis Program , and realtime measurements can be done using chirp transmitters. For radio amateurs the WSPR mode provides maps with real time propagation conditions between a network of transmitters and receivers. In AM broadcasting , the dramatic ionospheric changes that occur overnight in the mediumwave band drive a unique broadcast license scheme, with entirely different transmitter power output levels and directional antenna patterns to cope with skywave propagation at night. Very few stations are allowed to run without modifications during dark hours, typically only those on clear channels in North America. Otherwise, there would be nothing but interference on the entire broadcast band from dusk until dawn without these modifications. For FM broadcasting and the few remaining low-band TV stations , weather is the primary cause for changes in VHF propagation, along with some diurnal changes when the sky is mostly without cloud cover. The result is typically several stations being heard from another media market â€” usually a neighboring one, but sometimes ones from a few hundred kilometers away. Ice storms are also the result of inversions, but these normally cause more scattered omnidirection propagation, resulting mainly in interference, often among weather radio stations. Non-broadcast signals are also affected. Mobile phone signals are in the UHF band, ranging from to over Megahertz, a range which makes them even more prone to weather-induced propagation changes. In urban and to some extent suburban areas with a high population density , this is partly offset by the use of smaller cells, which use lower effective radiated power and beam tilt to reduce interference, and therefore increase frequency reuse and user capacity. However, since this would not be very cost-effective in more rural areas, these cells are larger and so more likely to cause interference over longer distances when propagation conditions allow. While this is generally transparent to the user thanks to the way that cellular networks handle cell-to-cell handoffs , when cross-border signals are involved, unexpected charges for international roaming may occur despite not having left the country at all. This often occurs between southern San Diego and northern Tijuana at the western end of the U. Since signals can travel unobstructed over a body of water far larger than the Detroit River , and cool water temperatures also cause inversions in surface air, this "fringe roaming" sometimes occurs across the Great Lakes , and between islands in the Caribbean. Signals can skip from the Dominican Republic to a mountainside in Puerto Rico and vice versa, or between the U. While unintended cross-border roaming is often automatically removed by mobile phone company billing systems, inter-island roaming is typically not.

Chapter 2 : Radio propagation - Wikipedia

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Detonation A detonation wave is essentially a shock supported by a trailing exothermic reaction. It involves a wave travelling through a highly combustible or chemically unstable medium, such as an oxygen-methane mixture or a high explosive. The chemical reaction of the medium occurs following the shock wave, and the chemical energy of the reaction drives the wave forward. A detonation wave follows slightly different rules from an ordinary shock since it is driven by the chemical reaction occurring behind the shock wavefront. In the simplest theory for detonations, an unsupported, self-propagating detonation wave proceeds at the Chapman-Jouguet flow velocity. A detonation will also cause a shock of type 1, above to propagate into the surrounding air due to the overpressure induced by the explosion. Schlieren photograph of the detached shock on a bullet in supersonic flight, published by Ernst Mach and Peter Salcher in Shadowgram of shock waves from a supersonic bullet fired from a rifle. The shadowgraph optical technique reveals that the bullet is moving at about a Mach number of 1. Left- and right-running bow waves and tail waves stream back from the bullet and its turbulent wake is also visible. Patterns at the far right are from unburned gunpowder particles ejected by the rifle. Bow shock detached shock [edit] Main article: Bow shock aerodynamics These shocks are curved and form a small distance in front of the body. Directly in front of the body, they stand at 90 degrees to the oncoming flow and then curve around the body. Detached shocks allow the same type of analytic calculations as for the attached shock, for the flow near the shock. Additionally, the shock standoff distance varies drastically with the temperature for a non-ideal gas, causing large differences in the heat transfer to the thermal protection system of the vehicle. See the extended discussion on this topic at Atmospheric reentry. These follow the "strong-shock" solutions of the analytic equations, meaning that for some oblique shocks very close to the deflection angle limit, the downstream Mach number is subsonic. See also bow shock or oblique shock Such a shock occurs when the maximum deflection angle is exceeded. A detached shock is commonly seen on blunt bodies, but may also be seen on sharp bodies at low Mach numbers. Space return vehicles Apollo, Space shuttle , bullets, the boundary Bow shock of a magnetosphere. The name "bow shock" comes from the example of a bow wave , the detached shock formed at the bow front of a ship or boat moving through water, whose slow surface wave speed is easily exceeded see ocean surface wave. These shocks appear as attached to the tip of sharp bodies moving at supersonic speeds. Supersonic wedges and cones with small apex angles. The attached shock wave is a classic structure in aerodynamics because, for a perfect gas and inviscid flow field, an analytic solution is available, such that the pressure ratio, temperature ratio, angle of the wedge and the downstream Mach number can all be calculated knowing the upstream Mach number and the shock angle. These follow the "weak-shock" solutions of the analytic equations. In rapid granular flows[edit] Shock waves can also occur in rapid flows of dense granular materials down inclined channels or slopes. Strong shocks in rapid dense granular flows can be studied theoretically and analyzed to compare with experimental data. Consider a configuration in which the rapidly moving material down the chute impinges on an obstruction wall erected perpendicular at the end of a long and steep channel. Impact leads to a sudden change in the flow regime from a fast moving supercritical thin layer to a stagnant thick heap. This flow configuration is particularly interesting because it is analogous to some hydraulic and aerodynamic situations associated with flow regime changes from supercritical to subcritical flows. Shock waves in astrophysics Astrophysical environments feature many different types of shock waves. Another interesting type of shock in astrophysics is the quasi-steady reverse shock or termination shock that terminates the ultra relativistic wind from young pulsars. Meteor entering events[edit] The Tunguska event and the Russian meteor event are the best documented evidence of the shock wave produced by a massive meteoroid. Technological applications[edit] In the examples below, the shock wave is controlled, produced by ex. Recompression shock on a transonic flow airfoil, at and above critical Mach number. These shocks appear when the flow over a transonic body is decelerated to subsonic speeds. Transonic wings, turbines Where the flow over the suction side of a transonic wing is accelerated to a supersonic speed, the resulting re-compression can be by either Prandtlâ€"Meyer compression or by the formation of a normal shock. This shock is of particular interest to makers of transonic devices because it can cause separation of the boundary layer at the point where it touches the transonic profile. This can then lead to full separation and stall on the profile, higher drag, or shock-buffet, a condition where the separation and the shock interact in a resonance condition, causing resonating loads on the underlying structure. This shock appears when supersonic flow in a pipe is decelerated. In Supersonic Propulsion -- ramjet , scramjet , unstart. In Flow Control -- needle valve, choked venturi. In this case the gas ahead of the shock is supersonic in the laboratory frame , and the gas behind the shock system is either supersonic oblique shocks or subsonic a normal shock Although for some oblique shocks very close to the deflection angle limit, the downstream Mach number is subsonic. The shock is the result of the deceleration of the gas by a converging duct, or by the growth of the boundary layer on the wall of a parallel duct. Combustion engines[edit] The wave disk engine also named "Radial Internal Combustion Wave Rotor" is a kind of pistonless rotary engine that utilizes shock waves to transfer energy between a high-energy fluid to a low-energy fluid, thereby increasing both temperature and pressure of the low-energy fluid. Memristors[edit] In memristors , under externally-applied electric field, shock waves can be launched across the transition-metal oxides, creating fast and non-volatile resistivity changes. Though shock waves are sharp discontinuities, in numerical solutions of fluid flow with discontinuities shock wave, contact discontinuity or slip line , the shock wave can be smoothed out by low-order numerical method due to numerical dissipation or there are spurious oscillations near shock surface by high-order numerical method due to Gibbs phenomena. There exist some other discontinuities in fluid flow than the shock wave. The slip surface 3D or slip line 2D is a plane across which the tangent velocity is discontinuous, while pressure and normal velocity are continuous. Across the contact discontinuity, the pressure and velocity are continuous and the density is discontinuous. A strong expansion wave or shear layer may also contain high gradient regions which appear to be a discontinuity. Some common features of these flow structures and shock waves and the insufficient aspects of numerical and experimental tools lead to two important problems in practices: In fact, correct capturing and detection of shock waves are important since shock waves have the following influences:

Chapter 3 : Shock wave - Wikipedia

This propagation law enters a characteristics law based upon that proposed by Whitham, but reformulated for the computation of axisymmetric shocks with varying density. An asymptotic self-preserving shock shape is investigated, and is computed for the case Î³ = 1Â·4.

Chapter 4 : Norman Austern (Author of Propagation of Strong Blast in an Atmosphere of Varying Density)

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