Exploring New Views of Mercury's Exosphere and Surface

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Multiple physical processes connect Mercury's neutral and ionized exosphere to its surface and vice-versa. Several key discoveries were made during MESSENGER's three flybys that provide new insight into exosphere-surface-magnetosphere interactions and connections. Many of the physical processes that generate the neutral and ionized exosphere also are linked to space weathering or maturation of Mercury's regolith. These processes (e.g., solar wind sputtering and penetration, electron-stimulated desorption, and insolation over the broad solar spectrum) strongly interact with Mercury's regolith to form new molecular ions and neutrals and to facilitate random and systematic volatile transport and deposition. Past geological activity, such as magmatic intrusions, regional metamorphism, extrusive resurfacing, and pyroclastic deposition, for example, have diversified surface chemistry and now influence exosphere composition. We incorporate recent theoretical modeling of electron precipitation to Mercury's surface, new laboratory measurements of ion production, and plausible surface chemistry into an enhanced and updated Mercury-system view that informs observational planning, exosphere and magnetosphere modeling, and laboratory initiatives.