

**Unified Understanding of Relativity and Quantum Mechanics through the  
Repulsion Graviton Space Model**

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Personal Publication

October 30, 2024

This paper is the English translation of the original Japanese version.

## **Abstract**

In this study, we propose the “Repulsion Graviton Space Model (Re:GraviS Model),” which elucidates the role of gravitons in the formation of cosmic structures and provides a framework for explaining gravity, dark matter, and dark energy. To support the validity of this model, we analyze the consistency between observational data and the “Galactic Rotation Curve Graviton-Modified Inverse Square Decay Model (Galactic Rotation Curve MiSAKi Model).” The MiSAKi Model incorporates the effects of gravitons into the circular orbital velocity equation derived from the spherically symmetric solution of Einstein’s field equations, namely the Schwarzschild solution. The insights obtained from this validation realize a unified understanding of relativity and quantum mechanics.

*Keywords:* Quantum Gravity Theory, Graviton, Dark Matter, Dark Energy, Black Hole, Galactic Rotation Curve

## **Introduction**

The discrepancy between observed and theoretical rotational velocities at the outer edges of galaxies has long been a major challenge in physics. This study proposes a novel hypothesis: gravitons exert a repulsive force against space, and gravity can be explained as “the entropic-driven reaction of space countering this repulsion.” Using the circular orbital velocity equation derived from the spherically symmetric solution to Einstein’s field equations (the Schwarzschild solution) and incorporating the effects of gravitons, we analyze galactic rotation curves through a fitting model, the Galactic Rotation Curve MiSAKi Model. Based on the results, this study explores the potential for addressing the longstanding challenge of unifying general relativity and quantum mechanics while providing new insights into the nature of the cosmos.

## **Model Overview and Theoretical Background**

The “Galactic Rotation Curve Graviton-Modified Inverse Square Decay Model (Galactic Rotation Curve MiSAKi Model)” employed in this study was derived by incorporating the effect of gravitons into the circular orbital velocity equation obtained from the Schwarzschild solution, a spherically symmetric solution to Einstein’s field equations. This model is based on the hypothesis that gravitons exert “spherically symmetric repulsive forces” against space, gradually decaying without interacting with matter, with their strength depending on the concentration of gravitons. Furthermore, the model assumes that gravitons act as dark matter on smaller scales, while on larger cosmic scales, they expand space and function as dark energy. By aligning the graviton concentration with the role of dark matter, this model resolves the longstanding mystery of “galactic rotation curves,” a significant challenge in physics.

## **Methodology**

Using a high-precision fitting verification script developed with AI tools (ChatGPT4.0), we analyzed the alignment between the Galactic Rotation Curve MiSAKi Model and the SPARC dataset of observed galactic rotation curves (175 galaxies). This analysis, performed using nonlinear least squares fitting, involved visualizing results through plots, evaluating adjusted determination coefficients, and examining residuals. To account for the influence of anti-gravitons, imaginary components arising when  $\alpha$  takes negative values were appropriately handled using numpy functions, enabling a comprehensive evaluation of the combined effects of gravitons and anti-gravitons. Furthermore, after completing all fittings, we conducted a comprehensive correlation analysis of key parameters, including the graviton concentration (parameter  $\alpha$ ), the graviton effect range (scale parameter  $R$ ), and other physical parameters such as observed velocity components, disk components, and bulge components. To mitigate the risk of overfitting, parameter ranges during fitting were constrained to appropriate limits ( $-150,000 < \alpha < 150,000$  and  $0.1 < R < 200$ ).

## Results and Discussion

The analysis confirmed a high degree of fit between the Galactic Rotation Curve MiSAKi Model and most galaxies, with a mean adjusted determination coefficient (adjusted  $R^2$ ) of 0.802, a median of 0.964, and a standard deviation of 0.332. Across the 175 analyzed cases, the high median adjusted  $R^2$  value of 0.964 and the small standard deviation of 0.332 demonstrate the model's accuracy. Residual distributions were random and confined to a narrow range (mean residual 0.110, standard deviation 5.58), with no signs of overfitting. This confirms that the model reproduces galactic rotation curves with high precision and reliability without excessive adaptation to observed data. Correlation analysis further revealed a very strong positive correlation between the graviton concentration parameter ( $\alpha$ ) and both the observed velocity and the disk velocity components (average observed velocity, Avg Vobs(r): 0.956; average disk velocity, Avg Vdisk(r): 0.863). This suggests that graviton concentration significantly influences galactic rotational velocities and aligns faithfully with the role of dark matter inferred from Einstein's equations. Additionally, the distributions of  $\alpha$  and the scale parameter R were found to be concentrated within specific ranges. The clustering of  $\alpha$  suggests a certain threshold or standard for graviton concentration on galactic scales. Furthermore, the scale parameter R, which represents the range of graviton effects, showed no dependency on  $\alpha$  or other physical parameters and consistently converged within a specific range. This indicates that graviton effects operate at a fixed scale independent of their concentration or the material density of individual galaxies. These findings clarify that gravitons exhibit no material interactions but instead gradually decay while exerting spherically symmetric repulsive forces against space, contributing to the maintenance of rotational velocities at the outer edges of galaxies through interactions with space. Furthermore, the absence of material interactions implies that gravitons do not interfere with the Higgs field or interact with Higgs particles responsible for imparting mass. This supports the unique characteristics required by conventional quantum mechanics, where gravitons are massless, closed strings capable of interdimensional movement. In this analysis,  $\alpha$  did not take zero or negative values, and thus no direct effects of anti-gravitons were observed. However, this result does not directly negate the existence of anti-gravitons because  $\alpha$  represents graviton concentration rather than the absolute number of gravitons. Based on these results, this study concludes that the mysterious force maintaining outer galactic rotational

velocities is “the graviton’s repulsive force against space.” The model’s fit with observational data and its non-interactive properties suggest that gravity, considered the weakest of the four fundamental forces, originates from “the entropic-driven reaction of space countering the graviton’s repulsive force,” establishing a causal relationship between graviton effects and spatial curvature. Moreover, the findings strongly suggest that the nature of dark matter is “the gravitons themselves,” while the nature of dark energy is “the graviton’s repulsive force against space.” This implies that the mysterious energy accelerating the universe’s expansion at superluminal speeds is highly likely to be “the graviton’s repulsive force against space.” The mechanism by which massless gravitons concentrate may involve their indirect gravitational effects, namely, entropy-driven spatial repulsion confining gravitons within space and causing them to converge at a single point. This process represents a form of self-causality, potentially consistent within black hole event horizons and spacetime singularities, where traditional physical laws are believed to break down. This study suggests that black holes begin to form when spatial repulsion momentarily surpasses the graviton’s repulsive force against space. Spacetime singularities may not form as mere zero-dimensional points but rather as complex spatial regions that compress inward while exhibiting quantum-like spatial spread. When spatial repulsion strength approaches that of graviton repulsion, the resulting spacetime singularity can be interpreted as a spacetime region where graviton repulsion and spatial repulsion are in perfect equilibrium. This framework allows for quantum effects within spacetime singularities, avoiding the infinities that have long posed challenges in traditional quantum mechanics. However, assuming perfect equilibrium between graviton repulsion and spatial repulsion might prevent quantum spread within the singularity. To reconcile this within quantum mechanics, it may be necessary to consider that gravitons transition from “open string” to “closed string” states under extreme conditions in spacetime singularities, allowing them to transform into energy and escape to other dimensions. In this interpretation, gravitons function as particles transmitting and preserving information across dimensions, ensuring that information is not lost beyond event horizons. This complements and potentially extends recent soft hair theory, providing a new perspective on resolving the black hole information paradox. Spacetime singularities may thus act as interdimensional gateways for gravitons, reconciling the information paradox while permitting quantum spread within singularities. Furthermore, this mechanism for black hole formation not only explains the phenomenon of time dilation in moderately strong gravitational fields but also

predicts changes in time within black holes themselves. In moderately strong gravitational fields, including those near black holes, graviton repulsion expands space, lengthening the Planck scale and increasing the minimum unit of quantum motion. This slows physical processes on the quantum level, effectively lengthening time. This matches relativity's prediction that objects near event horizons experience "time dilation" and appear to freeze from an external observer's perspective. Reversing this phenomenon to view it from an opposite perspective, the spacetime region near the event horizon where the object is located is characterized by extremely strong graviton repulsion, which significantly expands space. This causes physical motion at the quantum level to slow down, elongating the object's time. As a result, it can be explained that the observer's time appears relatively shorter in comparison. This consistency with relativity and actual phenomena further supports the theoretical model. However, within black holes, this relationship may invert. As spatial compression continues spontaneously, the Planck scale shortens, reducing the minimum unit of quantum motion. Consequently, physical processes accelerate on the quantum level, shortening time in the black hole's spacetime. From the perspective of an observer within the black hole, external objects may appear frozen, providing new insights into time changes in black holes. These findings suggest that observers' perception of constant time may be a cognitive illusion arising from synchronization with quantum movement speed and Planck scale within their respective spacetime regions. Such spacetime phenomena might require an extended graviton spacetime repulsive model, termed the Repulsion Graviton Space-Time Model (Re:GraviST Model), as an evolution of the Repulsion Graviton Space Model (Re:GraviS Model).

## **Conclusion**

In this study, the "Galactic Rotation Curve Graviton-Modified Inverse Square Decay Model (Galactic Rotation Curve MiSAKi Model)" was applied to analyze its alignment with the SPARC dataset of observed galactic rotation curves (175 galaxies). The results confirmed that the model demonstrates a high degree of consistency with observed galactic data, supporting the hypothesis that gravitons exert spherically symmetric repulsive forces against space. Furthermore, it was observed that the role of the parameter  $\alpha$ , which represents graviton concentration, aligns

with the role of dark matter within galaxies, while the scale parameter  $R$  converges within a specific range. These findings led to the following key conclusions and possibilities:

1. Gravitons exert spherically symmetric repulsive forces against space.
2. The essence of gravity lies in the entropy-driven repulsion of space in response to the repulsive force of gravitons on space. Furthermore, the reason why gravity is considered the weakest of the four fundamental forces is that it operates through an indirect mechanism mediated by space.
3. Dark matter is composed of gravitons, while dark energy is the repulsive force of gravitons against space.
4. The causal relationship between gravitons and space explains the mechanism of black hole formation and the quantum spread within spacetime singularities, enabling an understanding of singularities within the framework of quantum mechanics and offering a new perspective for resolving the information paradox.
5. The time dilation dependent on the strength of the gravitational field can be explained within the framework of quantum mechanics, and it is also suggested that time may be shortened inside the event horizon.
6. The application of the Repulsion Graviton Space Model (Re:GraviS Model) and its theoretical extension to the Repulsion Graviton Space-Time Model (Re:GraviST Model) suggests the possibility of unifying general relativity and quantum mechanics, which has long been considered challenging.

These insights obtained through this study provide a new understanding of the unresolved fundamental problems in physics, including gravity, dark matter, and dark energy. Moreover, the following issues are highlighted as future research directions based on the results of this analysis:

1. Additional Validation of the Theoretical Model

There is a need to further evaluate the validity of the theoretical model by verifying its consistency with observational data beyond galactic rotation curves, such as gravitational waves and cosmic microwave background radiation.

## 2. Further Research on Black Hole Formation Mechanisms

It is necessary to apply the relationship between gravitons and space to the process of black hole formation and to verify it in detail through observational data and simulations.

## 3. Further Research on Black Hole Spacetime Singularities

Detailed simulations are required to investigate the behavior of gravitons and space within spacetime singularities.

## 4. Interpretation of Proper Time

It is necessary to consider and examine the physical basis of the hypothesis that the “illusion of constant time” arises from the natural synchronization of awareness and bodily reaction speeds with the Planck scale and quantum scale movement speeds of each spacetime region.

Through these future validations, the Repulsion Graviton Space-Time Model (Re:GraviST Model) is strongly expected to be established as an essential foundation for the completion of a “quantum gravity theory.”

References: This research is based on high originality and general knowledge, hence no specific references are cited.

Data Used: SPARC Galaxy Rotation Curve Dataset (175 galaxies)

<https://astronomy.case.edu/2016/08/26/sparc-galaxy-database>



## Galactic Rotation Curve Graviton-Modified Inverse Square Decay Model (Galactic Rotation Curve MiSAKi Model)

$$v_{\text{total}}(r) = \sqrt{\alpha \left( 1 - \frac{1}{1 + \left(\frac{r}{R}\right)^2} \right)}$$

- $v_{\text{total}}(r)$ : The total rotational velocity of the galaxy at a distance  $r$  from the center.
- $\alpha$ : A variable parameter representing the concentration of gravitons.
- $R$ : A variable parameter representing the range of influence of gravitons.
- $r$ : The radius (distance from the center).

## Derivation Process

### 1. Einstein's Equation

Einstein's equation is the fundamental equation in the theory of relativity, describing the relationship between matter distribution and the curvature of space-time.

$$R_{\mu\nu} - \frac{1}{2}g_{\mu\nu}R = \frac{8\pi G}{c^4}T_{\mu\nu} \quad (1)$$

### 2. Adoption of the Schwarzschild Solution

Assuming that "gravitons exert a spherically symmetric repulsion on space," we adopt the Schwarzschild solution, which is a spherically symmetric solution to Einstein's equation.

$$ds^2 = - \left( 1 - \frac{2GM}{r} \right) c^2 dt^2 + \left( 1 - \frac{2GM}{r} \right)^{-1} dr^2 + r^2 d\theta^2 + r^2 \sin^2 \theta d\phi^2 \quad (2)$$

### 4. Derivation of Circular Orbital Velocity Equation

From the Schwarzschild solution, the velocity equation for circular orbits is derived as follows :

$$v_{\text{orbit}} = \sqrt{\frac{GM}{r}} \quad (3)$$

## 5. Substitution Based on the New Hypothesis

In the above equation,  $\frac{GM}{r}$  represents the gravitational attraction exerted by the central body on an object at distance  $r$ . Here, we introduce the hypothesis that "Gravitons exert a repulsive force on a spherically symmetric space that decays gradually without interacting with matter, and the strength of this force depends on the concentration of gravitons." To reflect this, we designed a modified inverse-square decay function, using the scale parameter  $R$  to represent the range of the graviton's influence, so that the graviton's repulsive force acts strongly at short distances and gradually maintains its influence at long distances. We replace  $\frac{GM}{r}$  with the following function, expressed as the product of the graviton concentration  $\alpha$  and the modified inverse-square decay function  $1 - \frac{1}{1+(\frac{r}{R})^2}$  :

$$\frac{GM}{r} \rightarrow \alpha \left( 1 - \frac{1}{1 + \left(\frac{r}{R}\right)^2} \right) \quad (4)$$

This equation represents the spherically symmetric repulsion of gravitons on space, decaying according to the inverse-square law as distance  $r$  increases. This allows us to incorporate the hypothesis into the formula while retaining the structural meaning of the original circular orbital velocity equation.

## 6. Final Derived Equation

As a result of applying the above substitution, the final circular orbital velocity equation that reproduces the galactic rotation curve is derived as follows :

$$v_{\text{total}}(r) = \sqrt{\alpha \left( 1 - \frac{1}{1 + \left(\frac{r}{R}\right)^2} \right)} \quad (5)$$

- $v_{\text{total}}(r)$  is the total rotational velocity of the galaxy at distance  $r$  from the center
- $\alpha$  is the variable ppp parameter representing the concentration of gravitons
- $R$  is the variable parameter representing the range of influence of gravitons
- $r$  is the radius (distance from the center)

To account for the influence of anti-gravitons, we do not ignore the imaginary component that appears when  $\alpha$  is negative, and instead handle it appropriately using numpy functions.

重力子空間斥力モデルによる  
相対性理論と量子力学の統合的理解

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個人著書

2024年10月30日

## 要旨

本研究では、アインシュタイン方程式の球対称解であるシュワルツシルト解から得られる円軌道速度式に重力子の効果を取り入れた、「銀河回転曲線重力子修正逆二乗減衰モデル(銀河回転曲線MiSAKiモデル)」と実際の観測データ的一致から、宇宙の構造形成における重力子の役割と、重力、ダークマター、ダークエネルギーの正体を統一的に説明する「重力子空間斥力モデル(Re:GraviSモデル)」を提案し、相対性理論と量子力学の統合的理解を実現します。

**Keywords:** 量子重力理論、重力子、ダークマター、ダークエネルギー、ブラックホール、銀河回転曲線

## 導入

銀河の回転曲線における銀河外縁部の回転速度の観測値と理論値のずれは、物理学における長年の課題とされてきました。本研究は、重力子が空間に対する斥力を持ち、重力の正体が、「その斥力に対するエントロピー駆動の空間の反発」によって説明されるとする新たな仮説を提案し、アインシュタイン方程式の球対称解(シュワルツシルト解)から得られる円軌道速度式に重力子の効果を取り入れたフィッティングモデル(銀河回転曲線MiSAKiモデル)を用いて銀河の回転曲線の解析を行います。その結果をもとに、重力の理論的な扱い方の違いから困難とされてきた、

「相対性理論と量子力学の統一」に向けた可能性と宇宙の真相を探究します。

## モデルの概要と理論的背景

今回使用する「銀河回転曲線重力子修正逆二乗減衰モデル(銀河回転曲線MiSAKiモデル)」は、アインシュタイン方程式の球対称解であるシュワルツシルト解から得られる円軌道速度式の成分に、重力子の効果を取り入れた式を代入することで導かれたものであり、「重力子は、物質と相互作用することなく緩やかに減衰する球対称の空間への斥力を持ち、その強さは重力子の集中度に依存する」という仮説を反映しています。さらに、このモデルは、より小さなスケールでは重力子がダークマターとしての役割を果たし、宇宙広域のような広いスケールでは空間を押し広げることでダークエネルギーとしての効果を発揮することを仮定しており、重力子の集中度がダークマターの役割と一致することで、物理学の長年の課題であった「銀河の回転曲線の謎」が解明されます。

## 解析手法

AIツール(ChatGPT4o)を用いて開発した高精度フィッティング検証用スクリプト(非線形最小二乗法を採用)を使用し、SPARC銀河回転曲線観測データセット(175個)と銀河回転曲線MiSAKiモデルとの一致を、プロット図による視覚化や調整後決定係数、残差の評価により解析します。また、反重力子の影響を考慮するために、 $\alpha$ が負の値をとる場合に生じる虚数成分はnumpy関数を用いて適切に扱い、重力子と反重力子の影響を統合的に評価します。さらに、すべてのフィッティングの完了後に、重力子の集中度を表す変数パラメータ $\alpha$ 、重力子の効果の範囲を表す変数スケールパラメータ $R$ 、銀河の観測速度成分、ディスク成分、バルジ成分などの物理パラメータを網羅的に相関分析し、相関係数を算出して相関関係を評価します。また、過剰フィッティングのリスクを考慮し、フィッティング時の変数パラメータは適切な範囲( $-150,000 < \alpha < 150,000$ 、 $0.1 < R < 200$ )に制限して検証を行います。

## 結果と考察

検証の結果、ほとんどの銀河とモデルの間で、極めて良好なフィッティングが確認されました(調整後決定係数 $R^2$ の平均値 0.802、中央値 0.964、標準偏差 0.332)。175個に及ぶ検証数に対して、調整後決定係数 $R^2$ の中央値は 0.964と高い値を示し、標準偏差は0.332と小さな値を示しました。また、残差の分布はランダムかつ小さな範囲(平均残差 0.110、標準偏差 5.58)に収まっており、過剰フィッティングの兆候は見られませんでした。したがって、本モデルは観測値に対して過剰に適合することなく、銀河の回転曲線を忠実かつ高精度に再現していることが確認されました。また、相関分析の結果、重力子の集中度を表す $\alpha$ が、観測速度およびディスク成分速度と非常に高い正の相関(平均観測速度 Avg Vobs(r) 0.956、平均ディスク速度 Avg Vdisk(r) 0.863)を持つことが確認されました。これは重力子の集中度が銀河の回転速度に強い影響を与えていることを意味し、アインシュタイン方程式により存在が示唆されているダークマターの役割と忠実に一致します。また、分析の結果、 $\alpha$ と $R$ の分布はそれぞれ特定の範囲に集中していることが確認されました。 $\alpha$ が特定の範囲に集中することは、銀河スケールでの重力子の集中度に一定の基準があることを示唆しています。また、重力子の効果の範囲を表すスケールパラメータ $R$ は、 $\alpha$ を含む他の物理パラメータに依存せず、一定の範囲に収束していました。これは、重力子の効果が、その集中度や各銀河の物質密度等の特性に依存せず、決められた一定のスケールで作用している可能性を示しています。この結果から、重力子が持つ空間への斥力は物質的な相互作用を示さず、緩やかに減衰しながら球対称に広がり、空間との相互作用を介して銀河外縁部の回転速度維持に貢献していることが明らかになりました。さらに、物質的な相互作用を示さないことは、重力子がヒッグス場と干渉せず、物質に質量を与えるヒッグス粒子との相互作用を示さないことを示唆しています。これは、従来の量子力学において、重力子が質量を持たず、閉じたひもとして次元間の移動が可能であるとする特異な性質の必要条件を満たす可能性があります。また、今回の検証では、 $\alpha$ が0や負の値をとることはなく、反重力子の影響は直接的には確認されませんでした。しかし、この結果は反重力子の存在の否定を直接的に意味しません。この理由は、重力子の集中度を表す $\alpha$ の本質が、そこに存在している重力子の絶対数を表すわけではないためです。今回の検証結果より、本研究においては、銀河外縁部の回転速度を維持している謎の力の正体は、「重力子が持つ空間に対する斥力である」と結論付けられました。また、今回の理論モデルの適合性や物質と相互作用しない等の結果から考察し、4つの基本的な力の中で最も弱いとされる重力の正体は、「重力子の空間への斥力に対するエントロピー駆動の空間の反発」であり、重力子の効果と空間の歪みは因果関係にあることを結論付けました。さらに、ダークマターの正

体は、「重力子そのもの」であり、ダークエネルギーの正体は「重力子が持つ空間への斥力」であることが強く示唆されました。これにより、光速を超えるスピードで宇宙を膨張させている謎のエネルギーの正体は、「重力子が持つ空間への斥力である可能性が非常に高い」、と結論付けられます。さらに、質量を持たないとされる重力子が集中するメカニズムは、重力子自身が間接的に発生させる重力、つまり、エントロピー駆動の空間の反発により自身が空間内部に閉じ込められ、その結果として重力子同士が一点に集中していくという、一種の自己因果律のようなものであることが考察されます。そして、このメカニズムは、ブラックホールが持つ事象の地平面の内側だけでなく、物理法則が破れるとされる時空特異点においてもその特性を保っている可能性が考えられます。つまり、ブラックホールは、「重力子の空間に対する斥力を、空間の反発が瞬間的に上回った場合」に形成が開始され、時空特異点は、単なる0次元の点として瞬間的に生じるのではなく、空間が「自ら」内側へ向かって自身を圧縮するような、非常に特殊で複雑な構造と量子的な広がりを持つ時空間領域として形成されていくかもしれません。そして、ある限界を超えた時点で、空間の反発の強さが重力子の斥力の強さへ近づき、最終的に形成された時空特異点は、密度や重力、曲率が無限大とされる0次元の「点」ではなく、「重力子の斥力と、空間の反発が完全に均衡している時空間領域である」と解釈することで、時空特異点において量子効果が働く余地が生まれます。このメカニズムは、従来の量子力学では扱えなかった時空特異点における無限大の問題を回避でき、量子力学の範囲で時空特異点を理解できる可能性を秘めています。しかし、両者が完全に均衡している状態と仮定すると、その時空間領域において量子的な広がりを持つことが不可能になる可能性も懸念されます。これを、量子力学に基づいて柔軟に解釈するためには、閉じたひもであり次元間を移動できるとされる重力子が、時空特異点において別次元空間へ逃げ出している可能性を考慮する必要があるかもしれません。この解釈では、重力子が「開いたひも」の状態から、時空特異点における極端な環境下においては、「閉じたひも」に変化することで、自身をエネルギーに変換し、情報を保持したまま別次元空間へ逃げ出すメカニズムが考えられます。そして、情報を別次元空間へ伝達し、保存する役割を担う「粒子」として機能することで、情報は別次元へ保存され、事象の地平面の内側で消失することがなくなります。この可能性は、近年提案されたソフトヘア理論に加えて、ブラックホール情報パラドックスの解決の糸口になるかもしれません。つまり、時空特異点は、重力子にとっての別次元空間ゲートとして機能している可能性があり、このメカニズムは、ブラックホールの情報パラドックスを解決するとともに、時空特異点における量子的な広がりを許容することになりえます。さらに、このブラックホール形成のメカニズムは、中等度に強い重力場において時間が延長する現象を説明するだけでなく、ブラックホール「内部」の時間の変化までを容易に予測します。事象の地平面付近を含む中等度に強い重力場では、重力子の空間への斥力により空間

が押し広げられることで、プランク長も引き伸ばされ、それに伴い、移動距離の最小単位も長くなることで、量子レベルで物理的移動が遅くなり、その時空間領域における時間が長くなります。これは、「ブラックホール外側の観測者の視点から、物体が事象の地平面に近づくとつれて時間の遅れが生じ、最終的に物体の動きが停止しているかのように見える」という相対性理論の予測と一致します。この現象を、視点を逆にして再現してみると、物体が位置する事象の地平面近くの時空間領域は、重力子の斥力が非常に強く、空間が大きく押し広げられている領域であるため、量子レベルで物理的移動が遅くなり、物体の時間が長くなることによって、相対的に観測者の時間が短くなっていると説明できます。このことから、理論モデルが相対性理論の予測や実際の観測と整合していることが確認できます。しかし、特に注目すべき点は、ブラックホール「内部」において、この関係性が逆転する可能性があるという点です。これは、ブラックホール形成開始の瞬間から空間が自発的なレベルで縮小を続け、それに伴いプランク長が縮められることで、移動距離の最小単位が短くなることに起因します。これにより、事象の地平面内部では量子レベルで物理的移動が速くなり、その時空間領域の時間は短くなります。つまり、ブラックホール「内部」の観測者の視点から見ると、外部の物体が止まって見えると予測され、この予測はブラックホール内部の時間変化に新しい視点を提供する可能性があります。さらに、時間の問題において、観測者の固有時間が常に一定に感じられる現象は、各時空間領域のプランク長や量子スケールでの移動速度に応じて、意識や身体の反応速度が必然的に同期されることにより生じる「時間一定の錯覚」である可能性が考察されます。このような時空間領域レベルの現象は、重力子空間斥力モデル(Re:GraviSモデル)をさらに時空間領域にまで拡張した、重力子時空間斥力モデル(Re:GraviSTモデル:Repulsion Graviton Space-Time Model)として理解する必要があるかもしれません。

## 結論

今回の研究では、「銀河回転曲線重力子修正逆二乗減衰モデル(銀河回転曲線MiSAKiモデル)」を用いて、SPARC銀河回転曲線観測データセット(175個)との適合を解析しました。その結果、モデルが銀河の観測データと高い整合性を示すことが確認され、重力子が空間への球対称の斥力を持つという仮説を支持する結果が得られました。さらに、重力子の集中度を表すパラメータ $\alpha$ の役割が、銀河におけるダークマターの役割の特徴と一致し、かつス



ケールパラメータ $R$ が一定の範囲に収束していることが確認されました。これらの結果は、以下の重要な結論と可能性を導きました。

1. 重力子は空間への球対称の斥力を持つ
2. 重力の正体は、重力子の空間への斥力に対するエントロピー駆動の空間の反発である。また、重力が4つの力の中で最弱である理由は、空間を介した間接的なメカニズムに基づいているためである
3. ダークマターの正体は重力子であり、ダークエネルギーの正体は重力子が持つ空間への斥力である
4. 重力子と空間の因果関係により、ブラックホール形成のメカニズムや時空特異点における量子的広がりが見解が説明され、量子力学の範囲で時空特異点の理解が可能となる。また、情報パラドックス解決へ向けた新たな視点が提供される
5. 重力場の強さに依存する時間の遅れを量子力学の範囲で説明可能となる。また、事象の地平内部では時間が短縮される可能性がある
6. 重力子空間斥力モデル(Re:GraviSモデル)や、理論を時空間まで拡張した重力子時空間斥力モデル(Re:GraviSTモデル)の適用により、これまで困難とされてきた相対性理論と量子力学の統一が可能となる

本研究を通じて得られたこれらの知見は、重力、ダークマター、ダークエネルギーという物理学の根幹に関わる未解決の問題に対して、新たな理解を提供するものです。また、今回の解析結果に基づく、さらなる研究の方向性として次の課題が挙げられます。

#### 1. 理論モデルの追加検証

銀河回転曲線以外の観測データ(重力波や宇宙背景放射等)との整合性を検証することで、理論モデルの妥当性をさらに評価する必要があること

#### 2. ブラックホール形成メカニズムのさらなる研究

重力子と空間の関係性をブラックホールの形成過程に適用し、観測データやシミュレーション等により詳細に検証する必要があること

### 3. ブラックホール時空特異点のさらなる研究

時空特異点における重力子と空間の挙動を詳細にシミュレーションする必要性があること

### 4. 固有時間の解釈

意識や身体の反応速度が、各時空間領域のプランク長や量子スケールでの移動速度に応じて必然的に同期されることにより「時間一定の錯覚」が生じている可能性について考察し、その物理的背景を検証する必要があること

これらの将来的な検証を通じて、「量子重力理論の完成」に向けた不可欠な基盤として「重力子時空間斥力モデル(Re:GraviSTモデル)」を確立させることが強く期待されます。

参考文献:本研究は独自性が高く、一般的な知見に基づいているため、特定の参考文献はありません。

使用したデータセット:SPARC銀河回転曲線データセット(175個)

<https://astronomy.case.edu/2016/08/26/sparc-galaxy-database>

## 銀河回転曲線重力子修正逆二乗減衰モデル (銀河回転曲線 MiSAKi モデル)

$$v_{\text{total}}(r) = \sqrt{\alpha \left( 1 - \frac{1}{1 + \left(\frac{r}{R}\right)^2} \right)}$$

- $v_{\text{total}}(r)$  : 中心からの距離  $r$  における銀河の総回転速度
- $\alpha$  : 重力子の集中度を表す変数パラメータ
- $R$  : 重力子の影響の範囲を表す変数パラメータ
- $r$  : 半径 (中心からの距離)

### 導出過程

#### 1. アインシュタイン方程式

アインシュタイン方程式は、相対性理論における物質分布と時空の曲がり方の関係を記述する基本方程式です。

$$R_{\mu\nu} - \frac{1}{2}g_{\mu\nu}R = \frac{8\pi G}{c^4}T_{\mu\nu} \quad (1)$$

#### 2. シュワルツシルト解の採用

「重力子が空間への球対称な斥力を持つ」という仮定より、アインシュタイン方程式の球対称解であるシュワルツシルト解を採用します。

$$ds^2 = - \left( 1 - \frac{2GM}{r} \right) c^2 dt^2 + \left( 1 - \frac{2GM}{r} \right)^{-1} dr^2 + r^2 d\theta^2 + r^2 \sin^2 \theta d\phi^2 \quad (2)$$

#### 4. 円軌道速度式の導出

シュワルツシルト解から、円軌道における速度式を求めると以下の式が得られます。

$$v_{\text{orbit}} = \sqrt{\frac{GM}{r}} \quad (3)$$

#### 5. 新しい仮定に基づく代入

上記の式における  $\frac{GM}{r}$  は、中心天体が距離  $r$  の物体に作用する引力を表していますが、ここで、「重力子は、物質と相互作用することなく緩やかに減衰する球対称の空間への斥力を持ち、その強さは重力子の集中度に依存する」と

いう仮説を導入するために、重力子の斥力が近距離で強く働き、遠距離でも緩やかに影響を維持するように、重力子の影響の範囲を表すスケールパラメータ  $R$  を用いた修正逆二乗減衰関数を設計し、 $\frac{GM}{r}$  の部分を重力子の集中度  $\alpha$  と修正逆二乗減衰関数  $1 - \frac{1}{1+(\frac{r}{R})^2}$  の積で表した次の関数で置き換えます。

$$\frac{GM}{r} \rightarrow \alpha \left( 1 - \frac{1}{1 + \left(\frac{r}{R}\right)^2} \right) \quad (4)$$

この式は、重力子の空間への球対称の斥力が、距離  $r$  に応じて修正逆二乗則に従いながら減衰する様子を表しています。これで、元の円軌道速度式の構造的な意味を保持しつつ、仮説を式に反映させることが可能となります。

## 6. 最終的に導かれた式

上記の代入を適用した結果、銀河回転曲線を再現する最終的な円軌道速度式は次の形に導かれます。

$$v_{\text{total}}(r) = \sqrt{\alpha \left( 1 - \frac{1}{1 + \left(\frac{r}{R}\right)^2} \right)} \quad (5)$$

- $v_{\text{total}}(r)$  : 中心からの距離  $r$  における銀河の総回転速度
- $\alpha$  : 重力子の集中度を表す変数パラメータ
- $R$  : 重力子の影響の範囲を表す変数パラメータ
- $r$  : 半径 (中心からの距離)

反重力子の影響も考慮するために、 $\alpha$  が負の場合に現れる虚数成分は無視せず、numpy 関数で適切に取り扱います。





UGC09037_rotmod	25128.78	5.549982	0.959671	15.198182	137.9273	7.23091	137.9297642	-0.00249146	5.038571585	133.8018	48.23864	0	56.964545	0
UGC09133_rotmod	69930.48	0.1	-0.02382	30.110588	264.1765	5.94382	264.1470325	0.0294381	24.08950572	169.375	30.46574	168.779	265.53074	679.11794
UGC09992_rotmod	1154.643	0.546297	0.955462	2.336	32.02	5.66	32.0182487	0.001751295	0.516376247	22.262	13.268	0	11.006	0
UGC10310_rotmod	5887.552	2.192953	0.995664	4.42	62.74286	5.06	62.79480316	-0.05194602	0.952092865	35.38429	18.43	0	15.16	0
UGC11455_rotmod	82092.02	5.728508	0.968982	15.364722	228.2444	7.75556	228.2703069	-0.02586246	12.2402897	249.5939	21.97472	0	396.47528	0
UGC11557_rotmod	9052.717	4.490537	0.981498	4.565	57.31667	7.875	57.78940712	-0.47274045	3.695726741	74.6275	11.3125	0	98.580833	0
UGC11820_rotmod	5766.035	1.552831	0.944763	5.576	51.205	2.938	51.02797629	0.17702371	6.205665124	19.477	16.072	0	29.292	0
UGC11914_rotmod	84855.38	0.440993	0.940862	3.726	279.5231	9.74015	279.5048667	0.0182102	6.114444792	204.6392	9.179692	202.966	859.68077	1058.4545
UGC12506_rotmod	57513.04	2.546488	0.855751	25.406452	228.871	14.4484	228.3227272	0.548240567	11.41613348	140.4713	51.12161	0	60.566774	0
UGC12632_rotmod	5547.564	2.755229	0.985445	5.6866667	60.18667	3.56067	59.98395775	0.202708921	1.810224101	26.414	17.538	0	7.504	0
UGC12732_rotmod	8128.786	3.323883	0.911591	8.1625	75.75	3.62688	75.35639905	0.393600949	5.024140739	29.31188	20.67063	0	6.880625	0
UGCA281_rotmod	1046.985	0.461573	0.996247	0.5785714	22.11429	1.78	22.05844032	0.055845393	0.511977967	14.29571	7.062857	0	36.737143	0
UGCA442_rotmod	3846.251	2.285353	0.989286	3.375	44.7875	2.00375	44.58189554	0.205604459	1.631804162	11.2475	17.46875	0	2.7425	0
UGCA444_rotmod	1557.182	1.21903	0.977357	1.3663889	26.23556	3.90861	26.0496576	0.185897955	1.332897136	4.521667	12.04167	0	0.9616667	0

### Summary Statistics

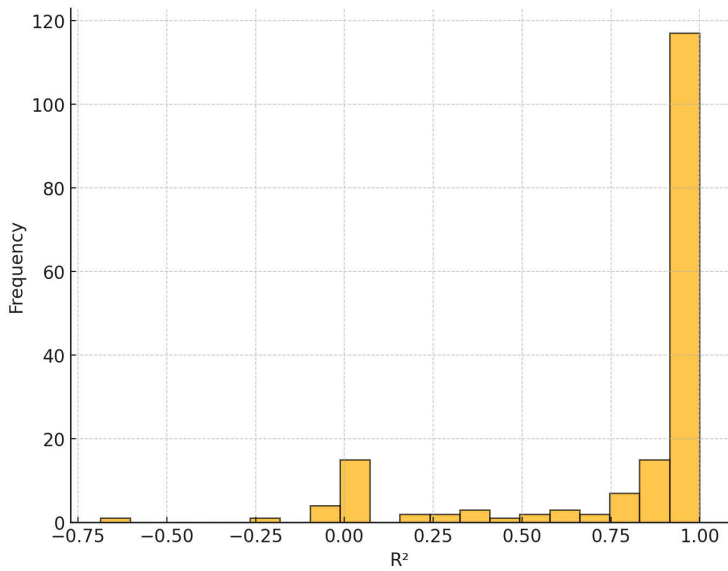
	count	mean	std	min	25%	50%	75%	max	25th Percentile	75th Percentile
Alpha	175	21502.130	23706.282	373.206	5650.550	11458.156	31696.972	126069.768	5650.550	31696.972
R	175	2.379	1.862	0.100	0.969	2.096	3.311	8.688	0.969	3.311
R^2	175	0.796	0.351	-0.687	0.859	0.964	0.988	0.999	0.859	0.988
Avg_Radius	175	8.371	7.599	0.405	3.281	5.672	10.498	41.086	3.281	10.498
Avg_Vobs	175	108.751	76.537	10.689	50.471	80.664	167.094	355.059	50.471	167.094
Avg_errV	175	5.770	3.397	0.625	3.284	5.186	7.280	21.237	3.284	7.280
Avg_Predicted_Velocity	175	108.641	76.599	10.532	50.329	80.591	167.333	355.059	50.329	167.333
Avg_Residual	175	0.110	0.434	-1.225	-0.033	0.008	0.175	2.602	-0.033	0.175
Residual_Std_Dev	175	5.577	5.419	0.182	1.838	3.300	8.130	27.414	1.838	8.130
Avg_Vdisk	175	79.166	70.220	4.522	26.415	44.211	134.305	262.901	26.415	134.305
Avg_Vgas	175	19.716	9.891	3.898	13.398	17.538	24.840	63.507	13.398	24.840
Avg_Vbul	175	22.289	52.434	0.000	0.000	0.000	0.000	211.814	0.000	0.000
Avg_SBdisk	175	104.221	171.701	0.962	10.927	29.292	128.520	964.706	10.927	128.520
Avg_SBbul	175	68.717	255.214	0.000	0.000	0.000	0.000	1992.620	0.000	0.000

### R<sup>2</sup> Summary Statistics

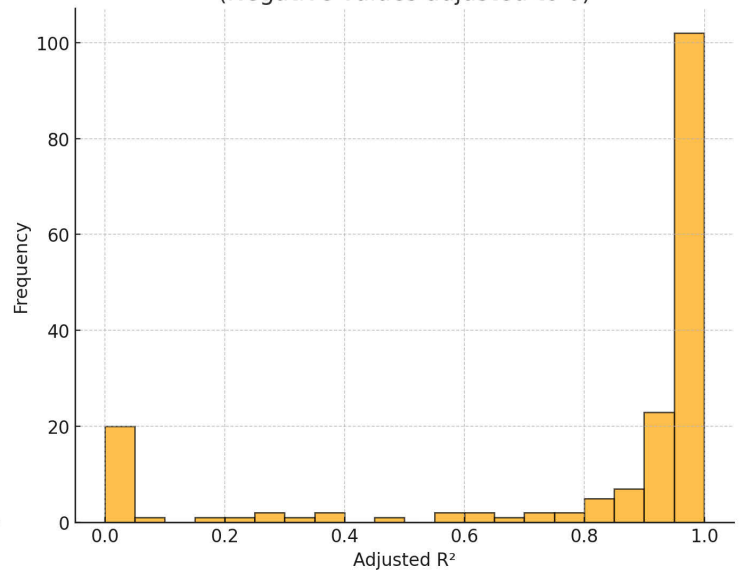
Metric	Original R <sup>2</sup>	Adjusted R <sup>2</sup>
Mean	0.796	0.802
Median	0.964	0.964
Standard Deviation	0.351	0.332
Min	-0.687	0.000
Max	0.999	0.999

(Negative R<sup>2</sup> values have been adjusted to 0.)

Histogram of Original R<sup>2</sup> Values



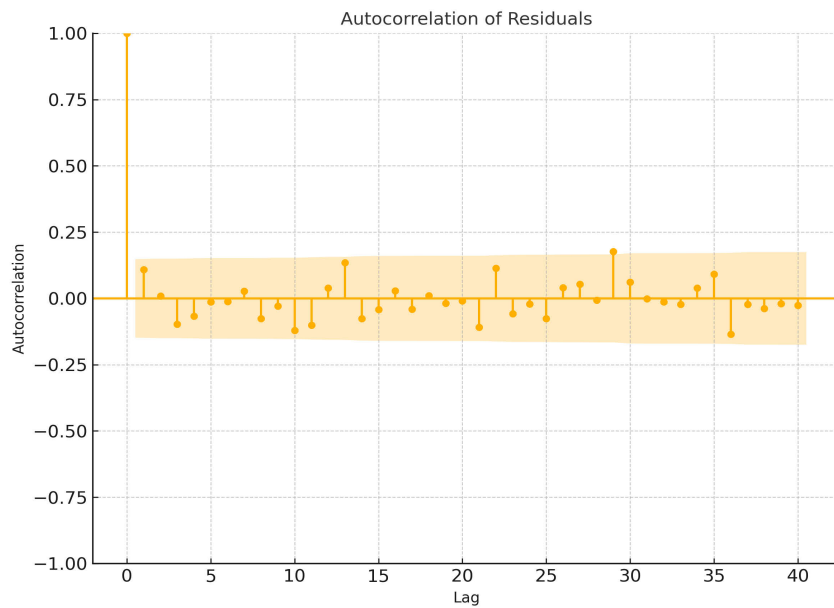
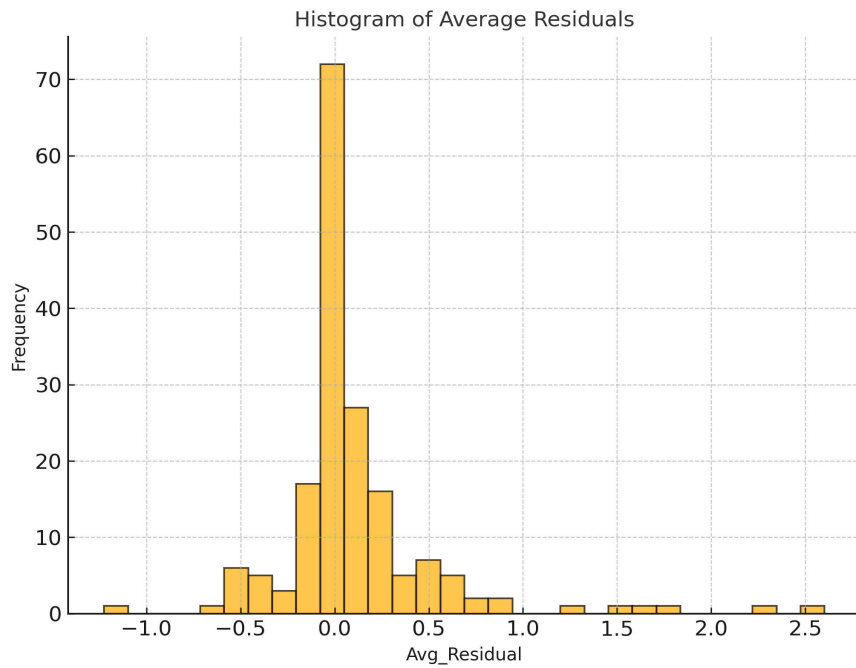
Histogram of Adjusted R<sup>2</sup> Values  
(Negative values adjusted to 0)





## Summary of Residuals for All Observations

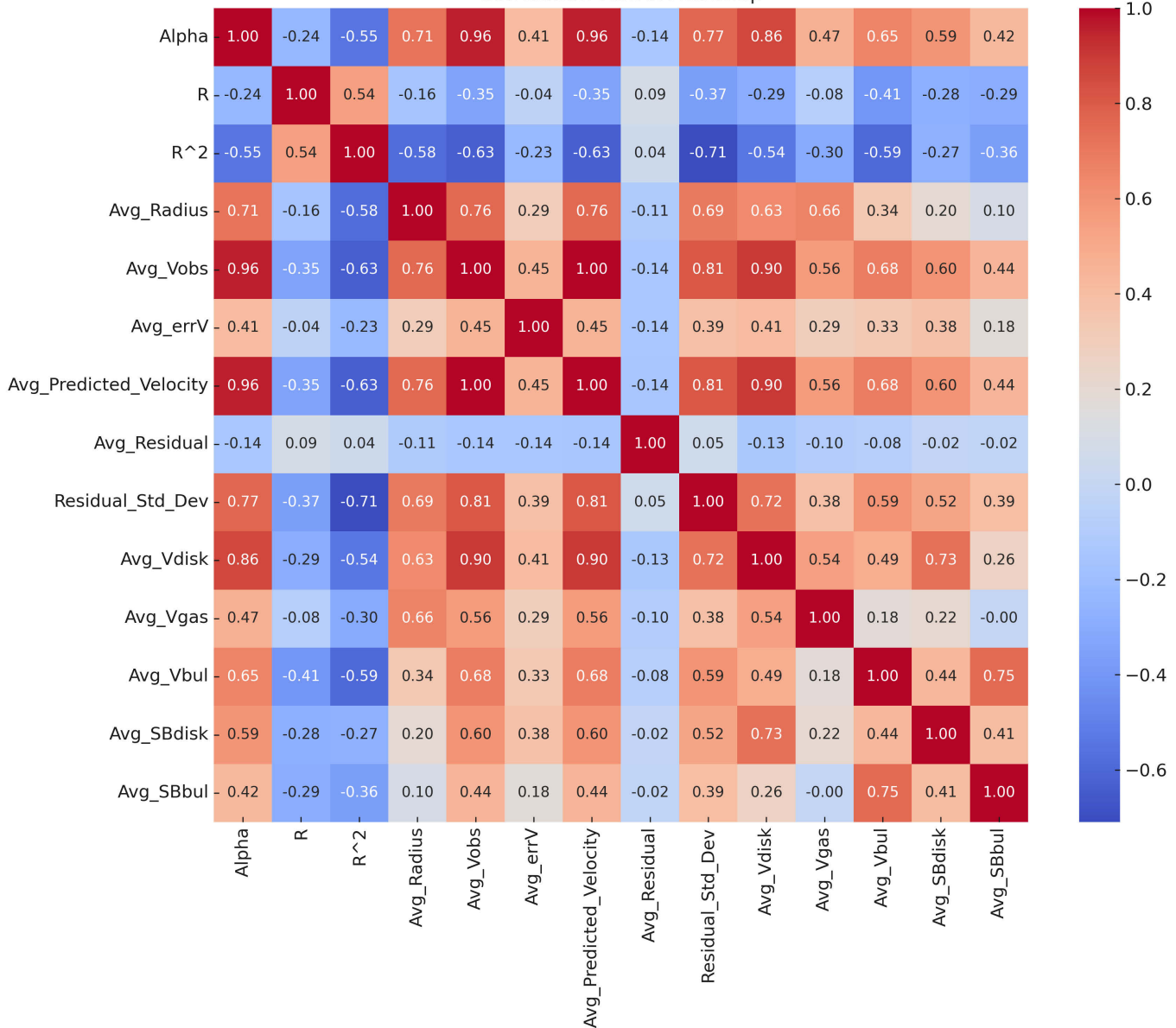
Metric	Value
Overall Average Residual	0.110
Overall Standard Deviation of Residuals	5.58



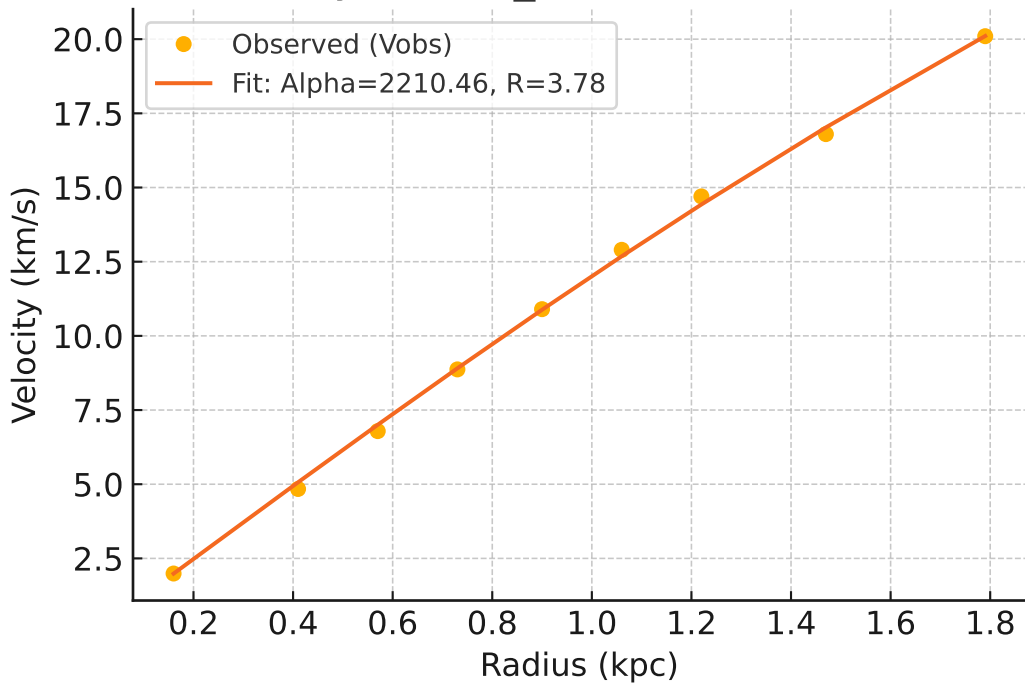
Pearson Correlation Matrix

	Alpha	R	R^2	Avg_Radius	Avg_Vobs	Avg_errV	Avg_Predicted_Velocity	Avg_Residual	Residual_Std_Dev	Avg_Vdisk	Avg_Vgas	Avg_Vbul	Avg_SBdisk	Avg_SBbul
Alpha	1	-0.240	-0.548	0.714	0.956	0.411	0.956	-0.137	0.766	0.863	0.469	0.653	0.588	0.419
R	-0.240	1	0.544	-0.157	-0.349	-0.037	-0.349	0.088	-0.366	-0.289	-0.081	-0.408	-0.280	-0.289
R^2	-0.548	0.544	1	-0.579	-0.632	-0.228	-0.632	0.039	-0.709	-0.540	-0.303	-0.591	-0.275	-0.365
Avg_Radius	0.714	-0.157	-0.579	1	0.759	0.293	0.759	-0.109	0.694	0.629	0.665	0.338	0.195	0.095
Avg_Vobs	0.956	-0.349	-0.632	0.759	1	0.450	1.000	-0.138	0.811	0.903	0.564	0.683	0.598	0.443
Avg_errV	0.411	-0.037	-0.228	0.293	0.450	1	0.450	-0.139	0.387	0.412	0.286	0.327	0.377	0.178
Avg_Predicted_Velocity	0.956	-0.349	-0.632	0.759	1.000	0.450	1	-0.144	0.810	0.903	0.564	0.683	0.598	0.443
Avg_Residual	-0.137	0.088	0.039	-0.109	-0.138	-0.139	-0.144	1	0.054	-0.131	-0.099	-0.080	-0.015	-0.024
Residual_Std_Dev	0.766	-0.366	-0.709	0.694	0.811	0.387	0.810	0.054	1	0.722	0.380	0.595	0.522	0.393
Avg_Vdisk	0.863	-0.289	-0.540	0.629	0.903	0.412	0.903	-0.131	0.722	1	0.545	0.485	0.727	0.263
Avg_Vgas	0.469	-0.081	-0.303	0.665	0.564	0.286	0.564	-0.099	0.380	0.545	1	0.181	0.218	-0.002
Avg_Vbul	0.653	-0.408	-0.591	0.338	0.683	0.327	0.683	-0.080	0.595	0.485	0.181	1	0.438	0.749
Avg_SBdisk	0.588	-0.280	-0.275	0.195	0.598	0.377	0.598	-0.015	0.522	0.727	0.218	0.438	1	0.405
Avg_SBbul	0.419	-0.289	-0.365	0.095	0.443	0.178	0.443	-0.024	0.393	0.263	-0.002	0.749	0.405	1

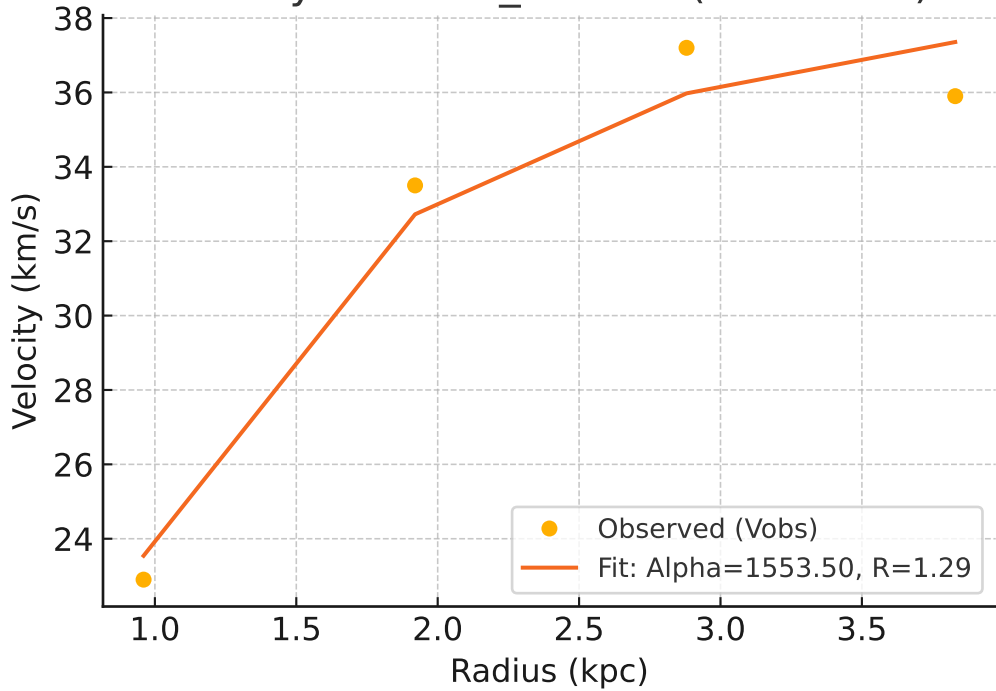
Correlation Matrix Heatmap



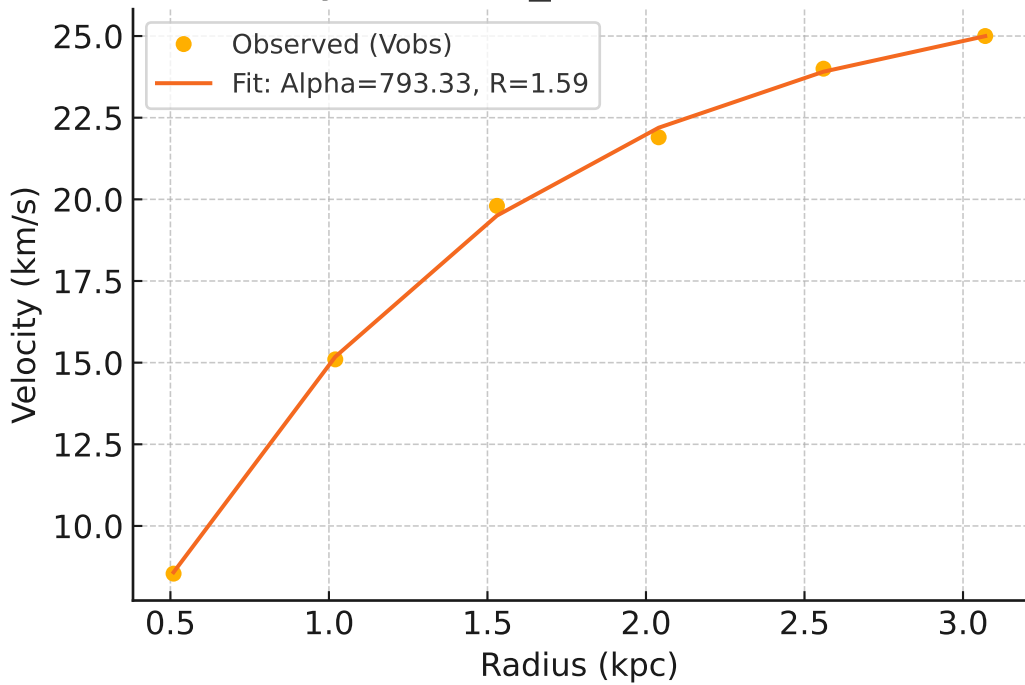
# Galaxy: CamB\_rotmod ( $R^2=0.999$ )



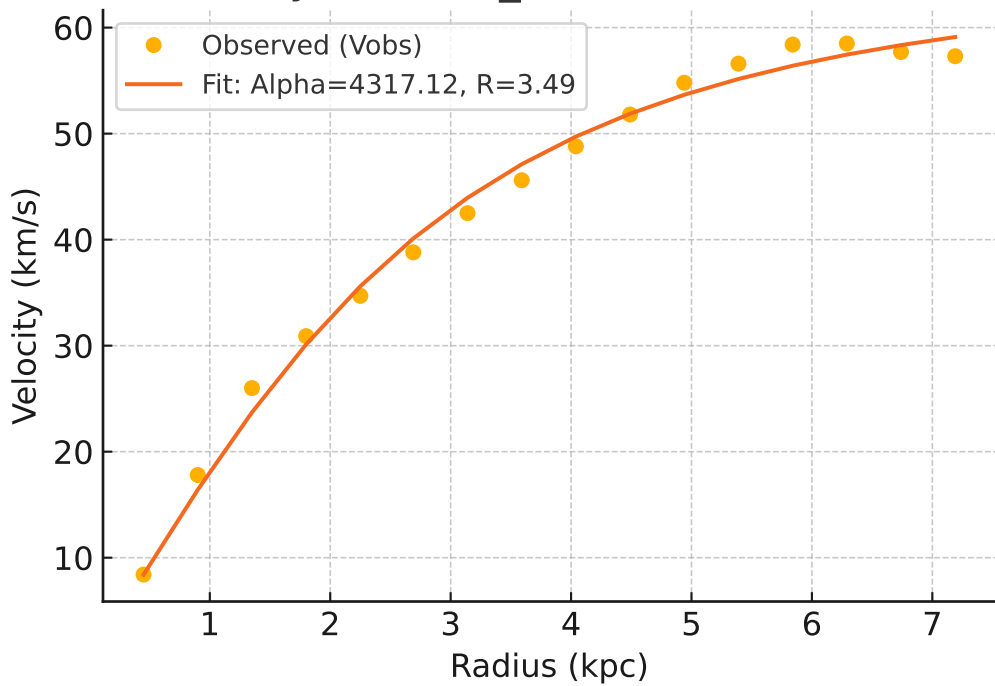
# Galaxy: D512-2\_rotmod ( $R^2=0.963$ )



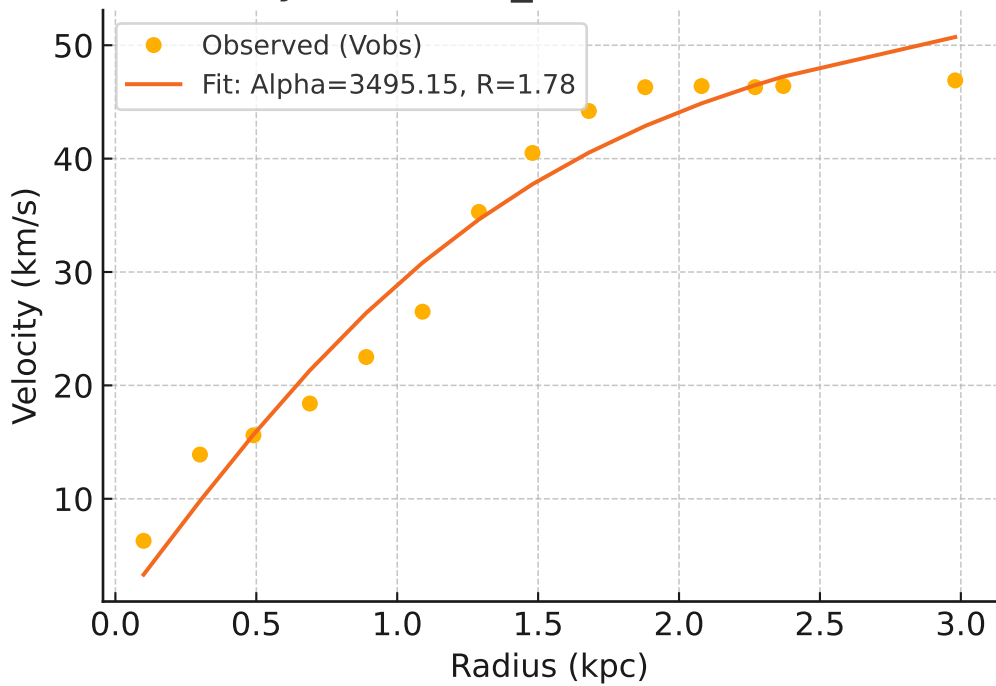
# Galaxy: D564-8\_rotmod ( $R^2=0.999$ )



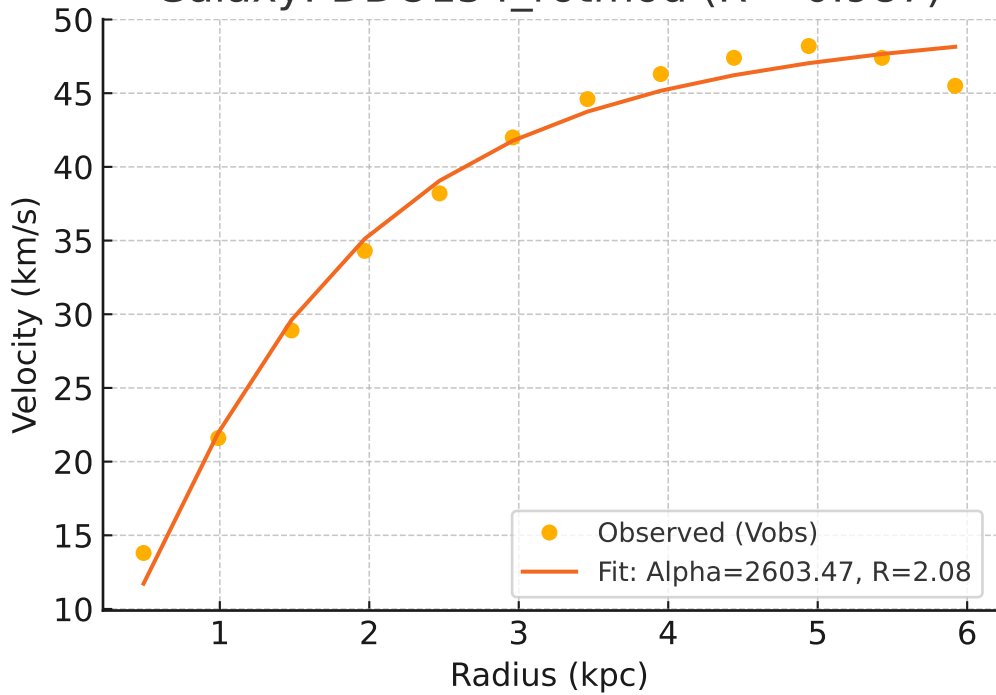
# Galaxy: D631-7\_rotmod ( $R^2=0.992$ )



# Galaxy: DDO064\_rotmod ( $R^2=0.958$ )

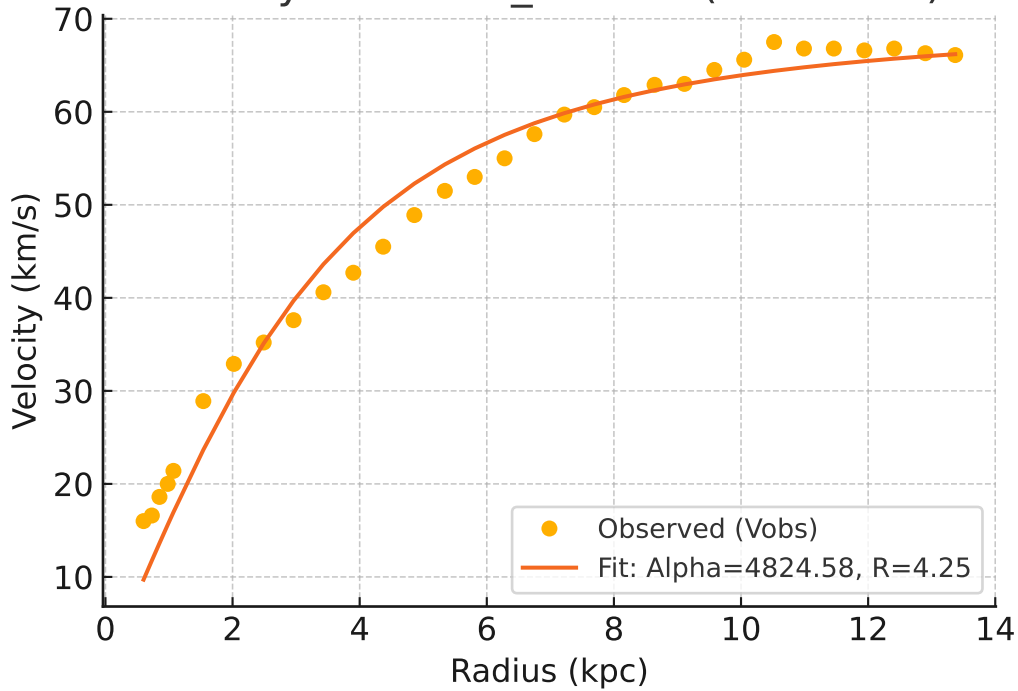


# Galaxy: DDO154\_rotmod ( $R^2=0.987$ )

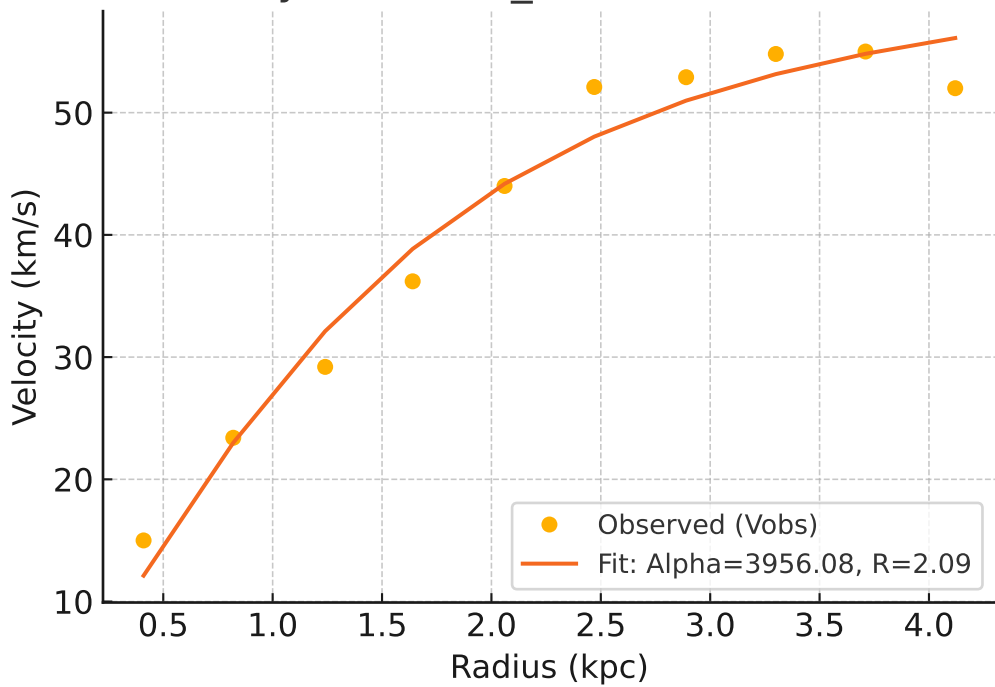




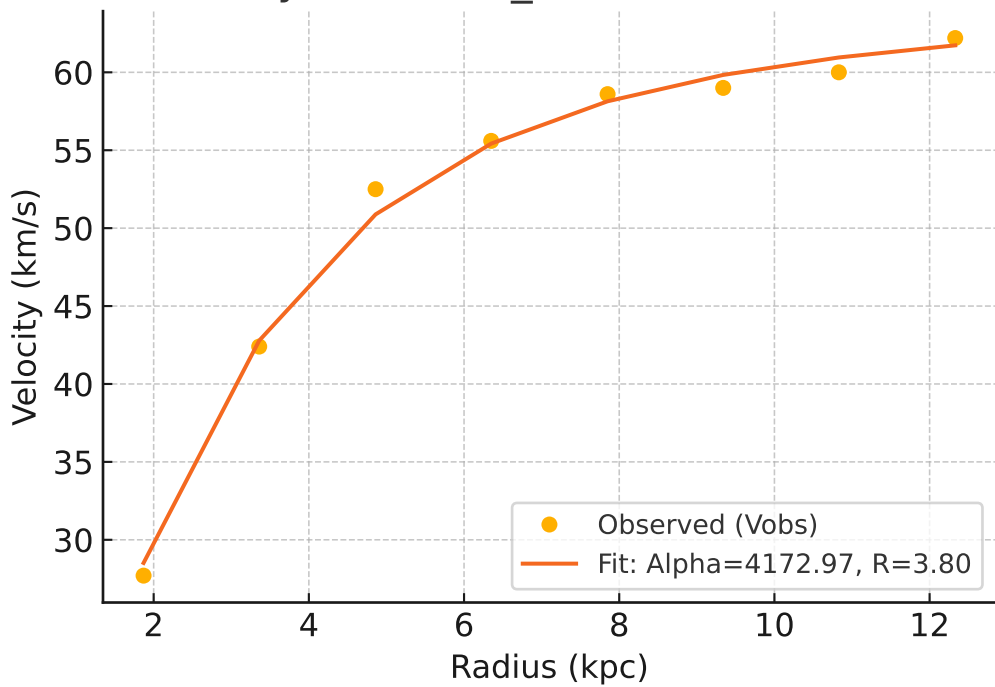
# Galaxy: DDO161\_rotmod ( $R^2=0.971$ )



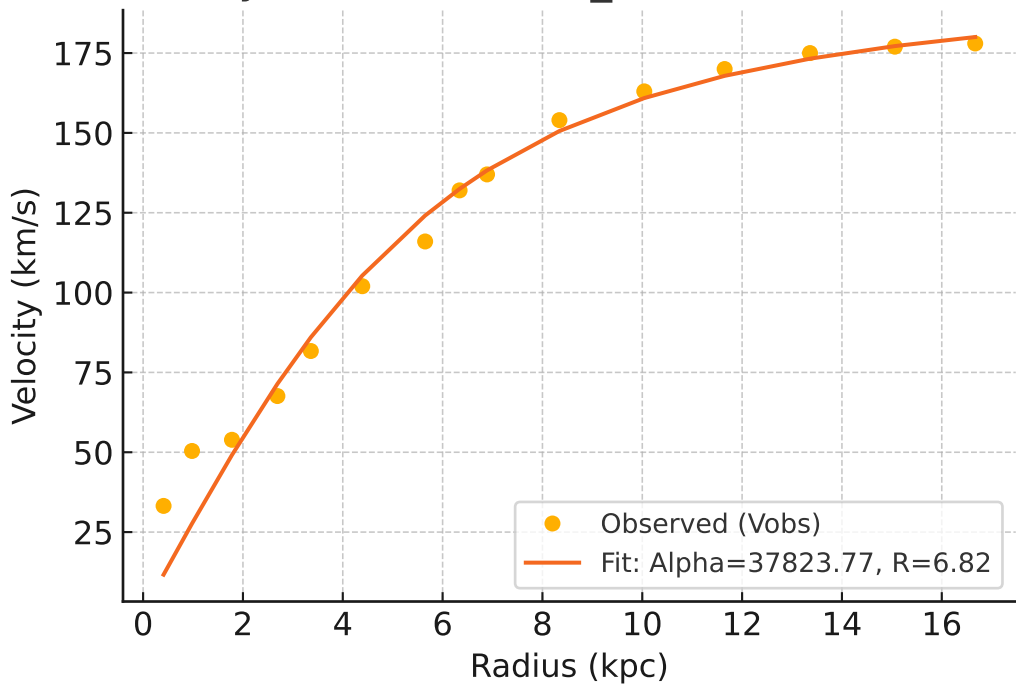
# Galaxy: DDO168\_rotmod ( $R^2=0.967$ )



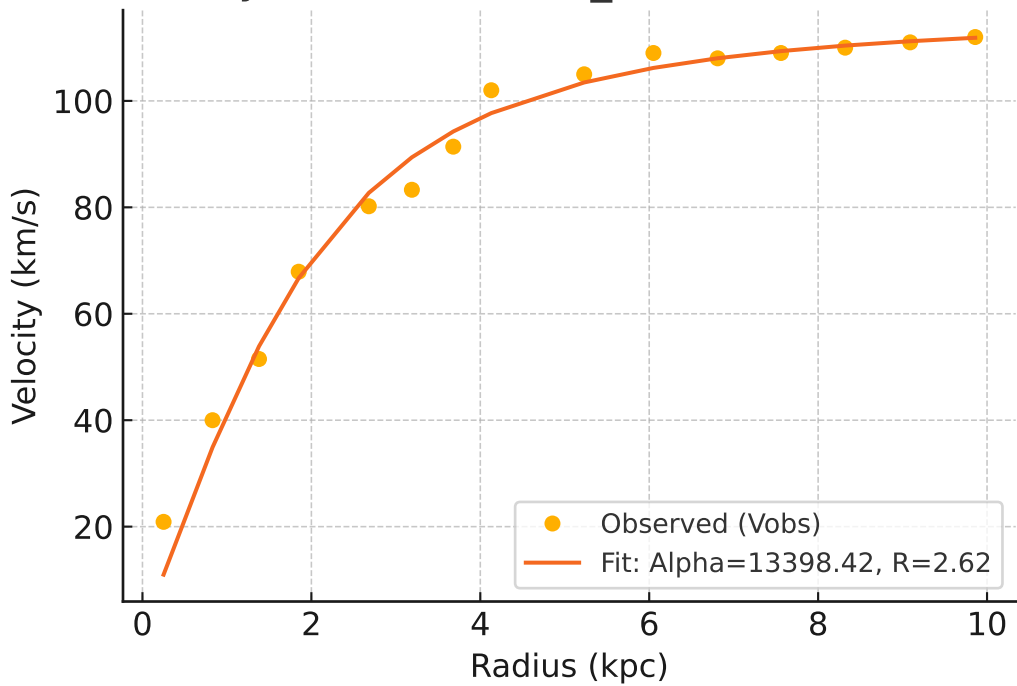
# Galaxy: DDO170\_rotmod ( $R^2=0.994$ )



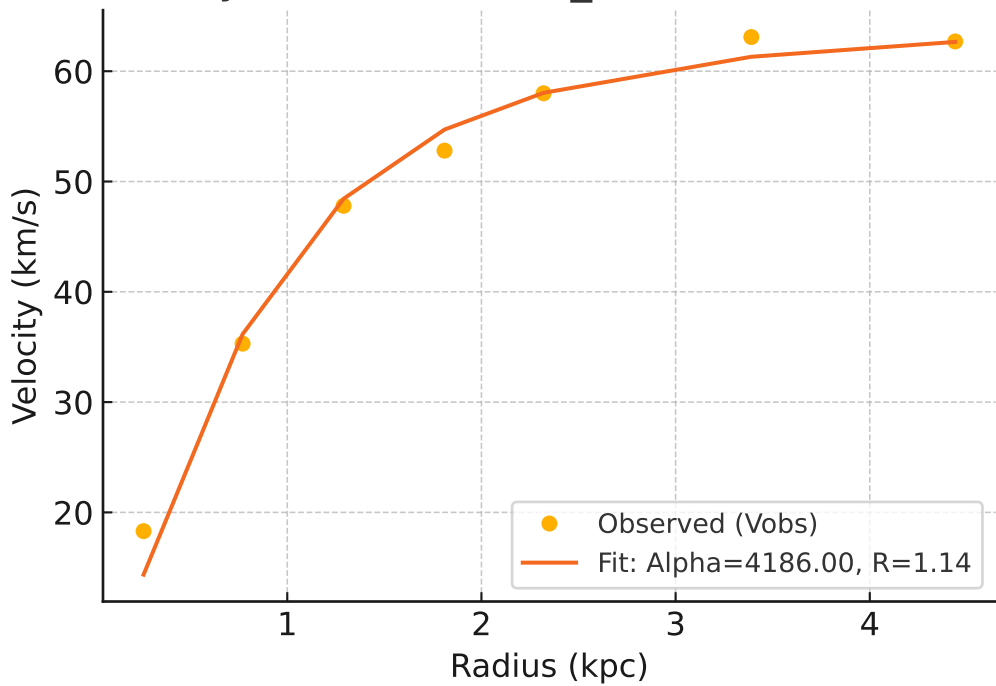
# Galaxy: ESO079-G014\_rotmod ( $R^2=0.969$ )



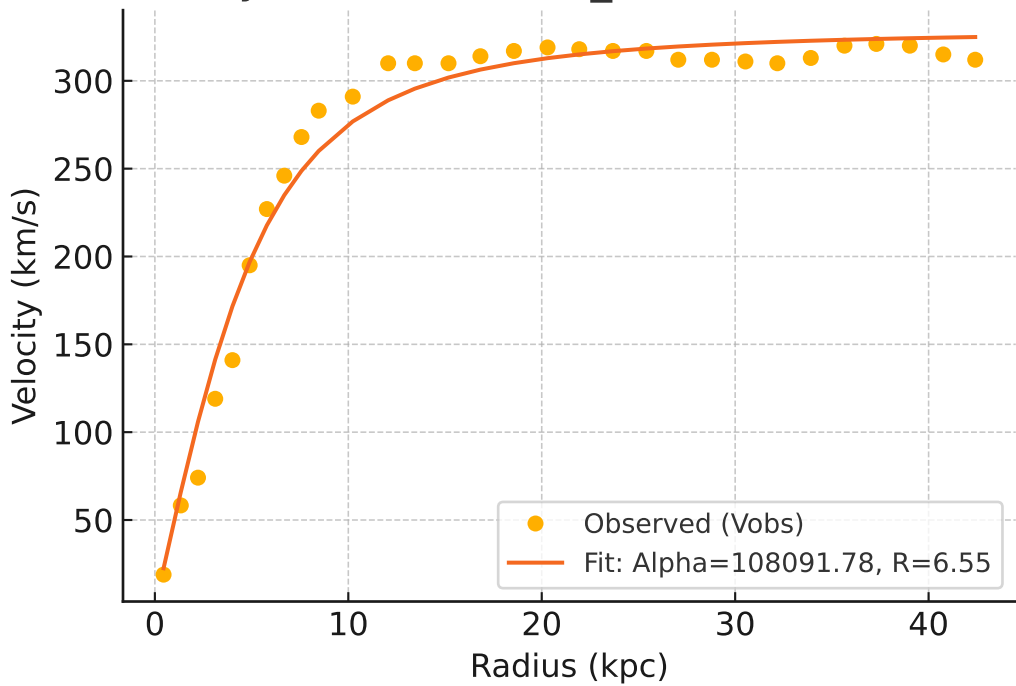
# Galaxy: ESO116-G012\_rotmod ( $R^2=0.982$ )



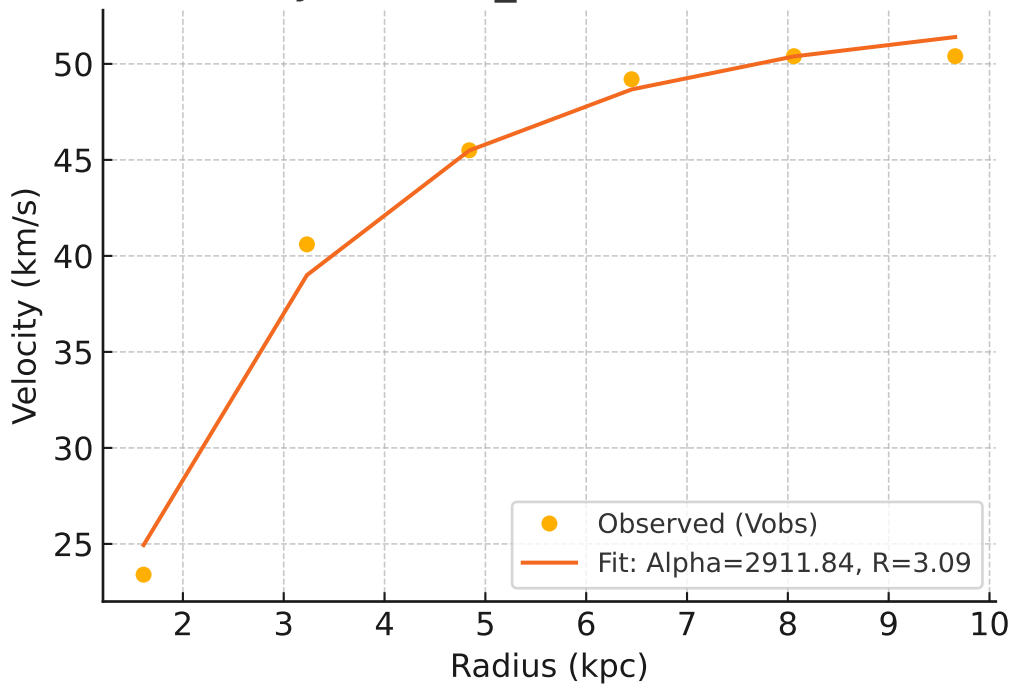
# Galaxy: ESO444-G084\_rotmod ( $R^2=0.985$ )



# Galaxy: ESO563-G021\_rotmod ( $R^2=0.976$ )

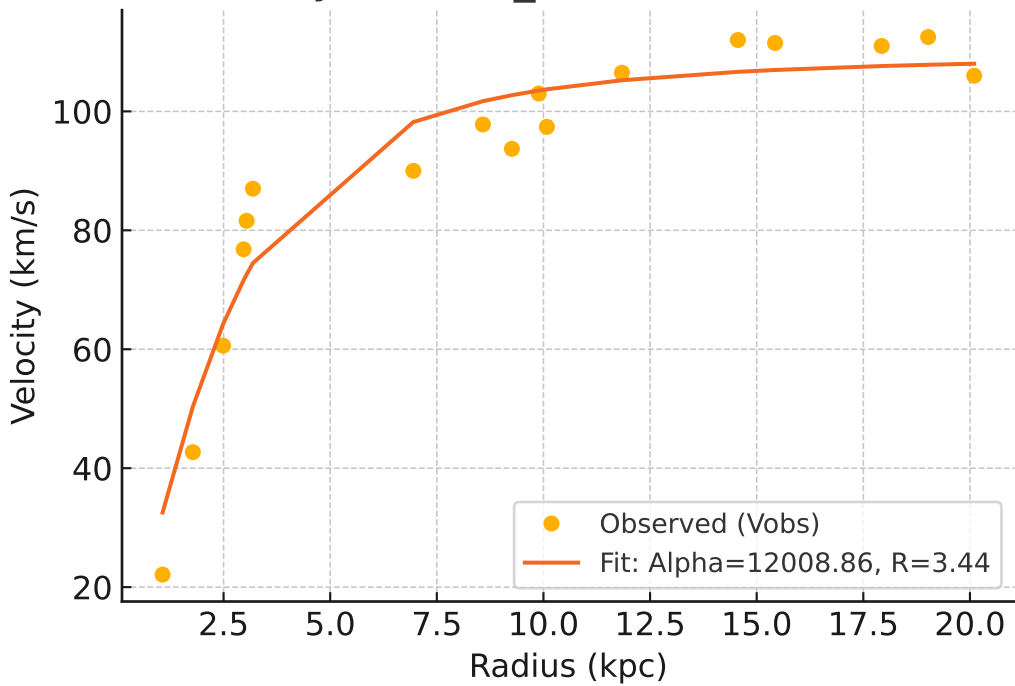


# Galaxy: F561-1\_rotmod ( $R^2=0.989$ )

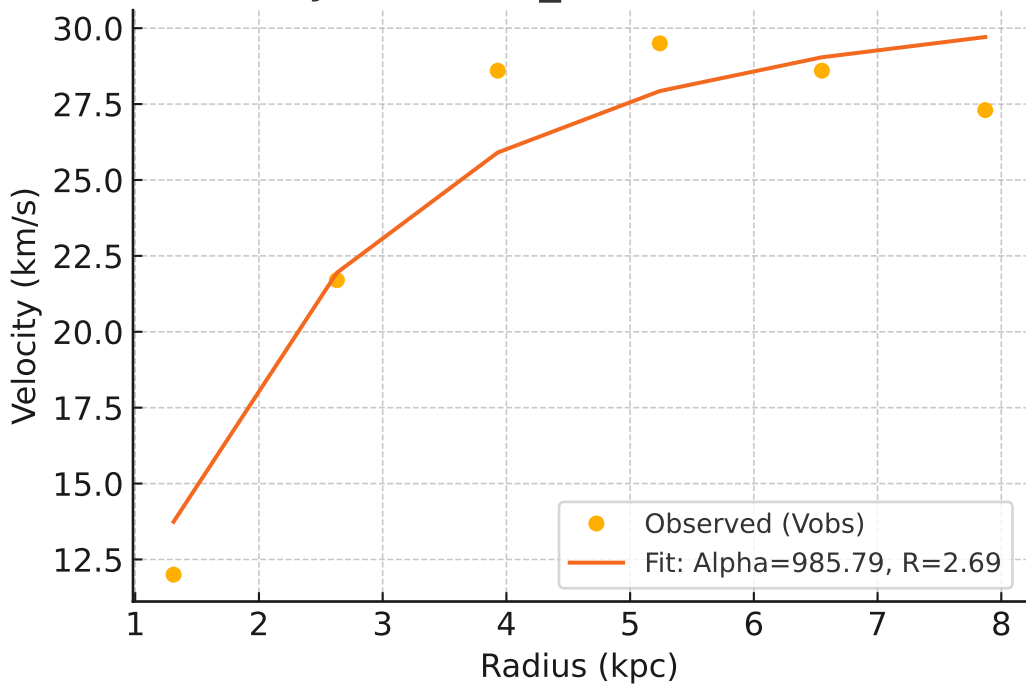




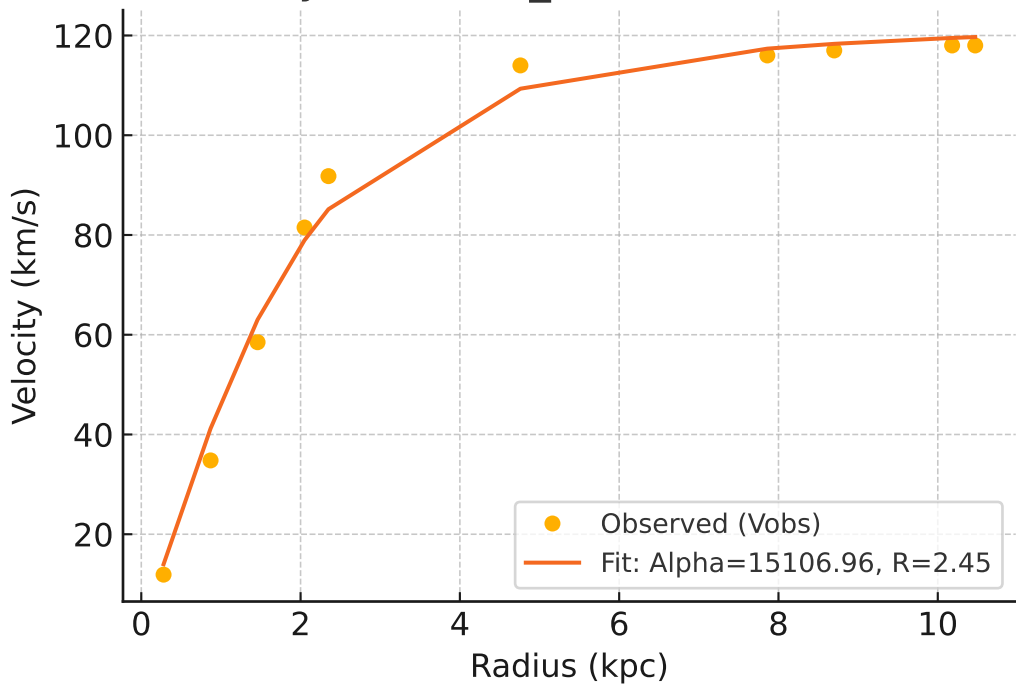
# Galaxy: F563-1\_rotmod ( $R^2=0.931$ )



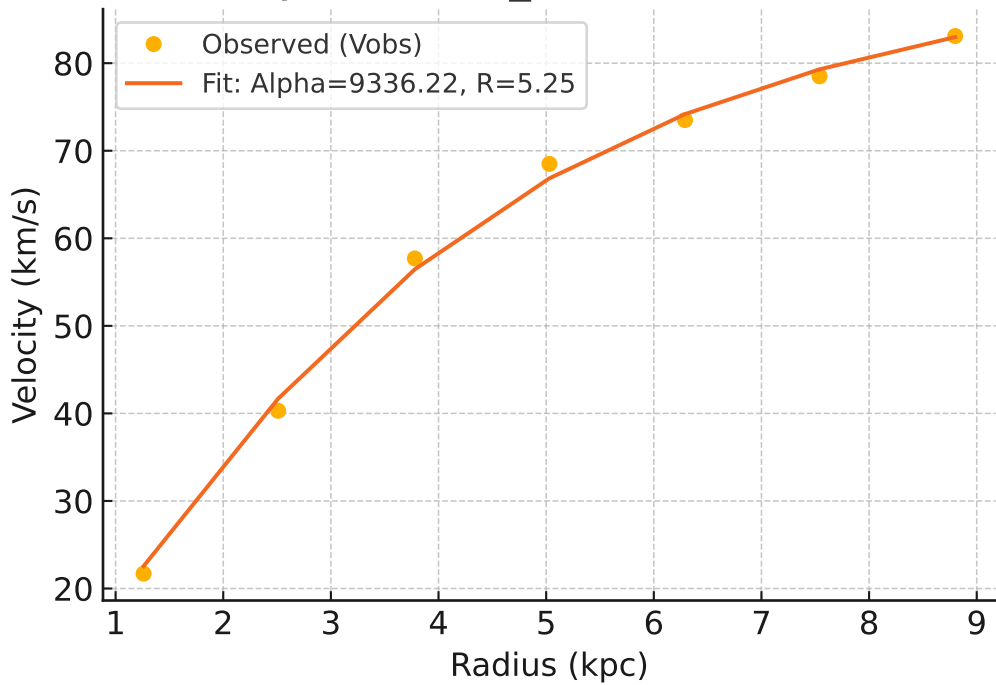
# Galaxy: F563-V1\_rotmod ( $R^2=0.918$ )



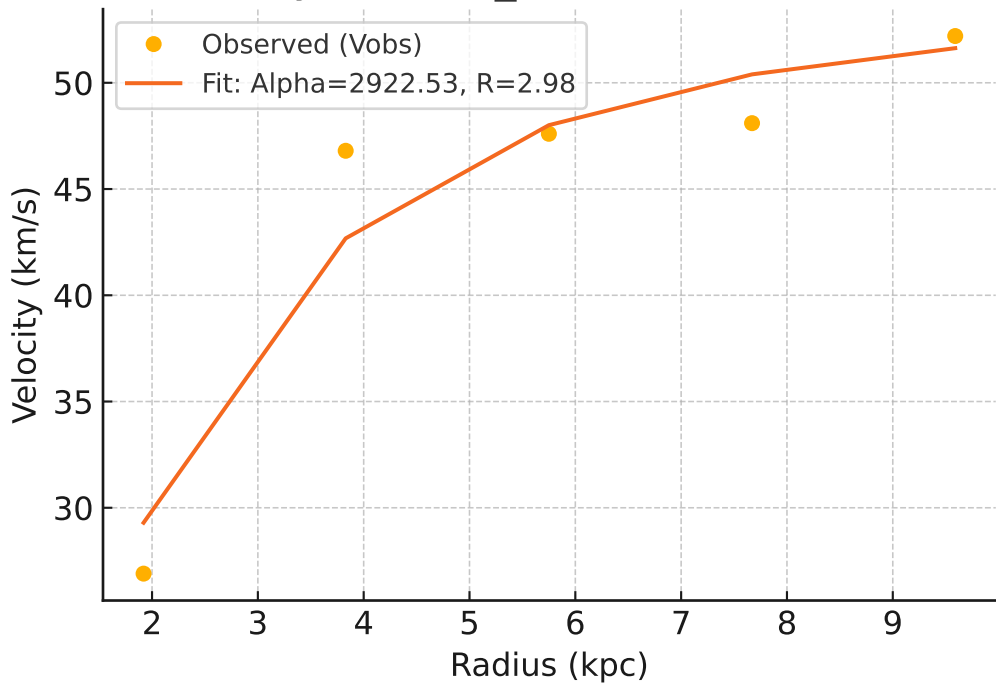
# Galaxy: F563-V2\_rotmod ( $R^2=0.989$ )



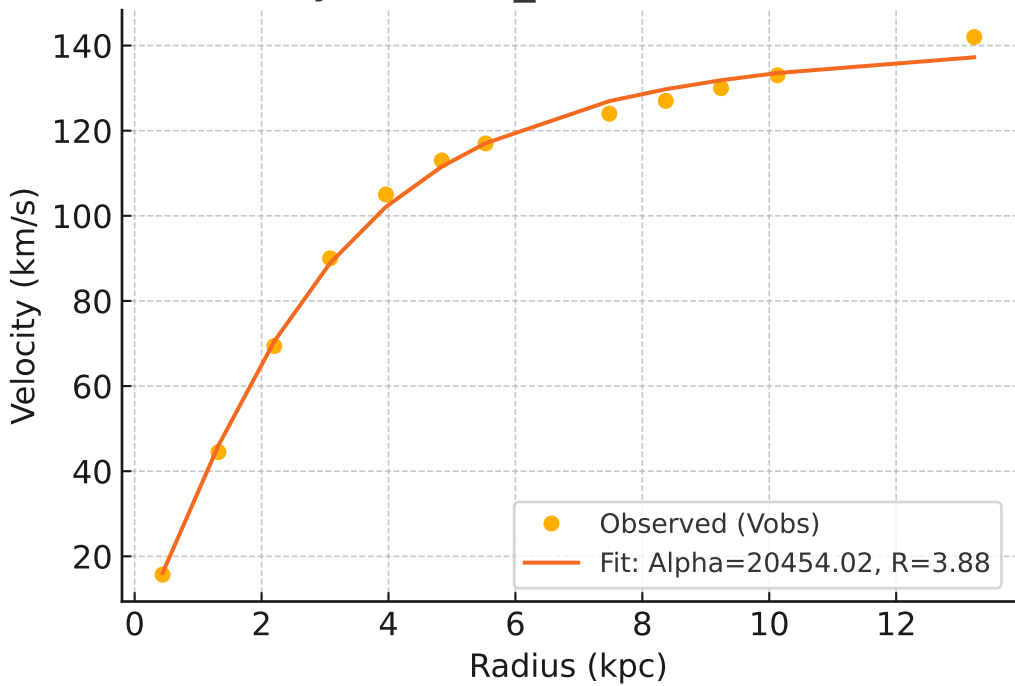
# Galaxy: F565-V2\_rotmod ( $R^2=0.997$ )



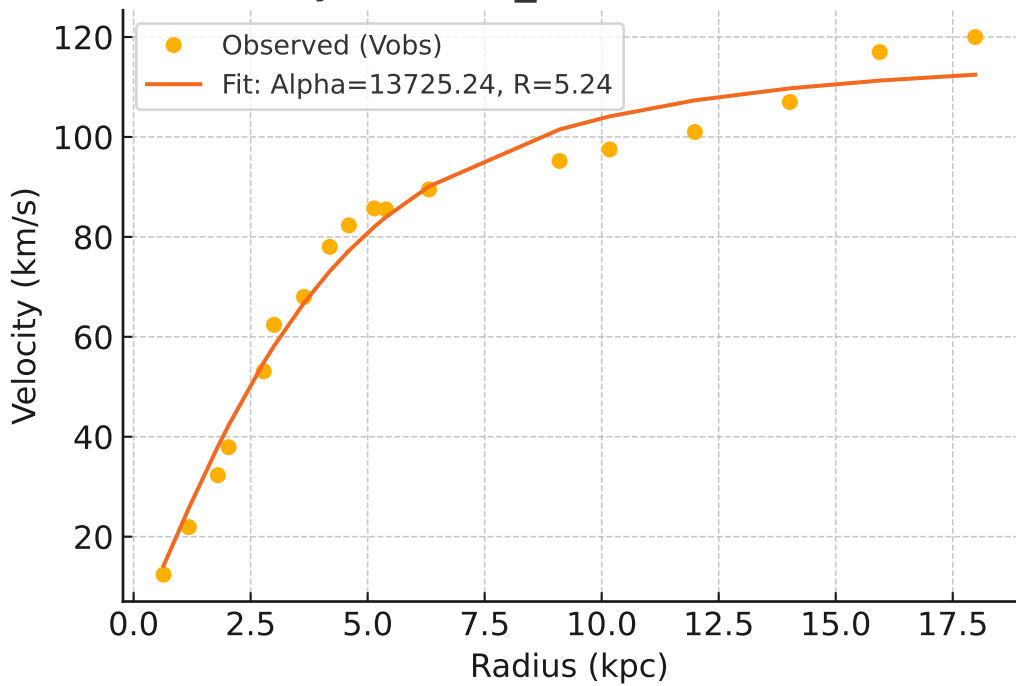
# Galaxy: F567-2\_rotmod ( $R^2=0.928$ )



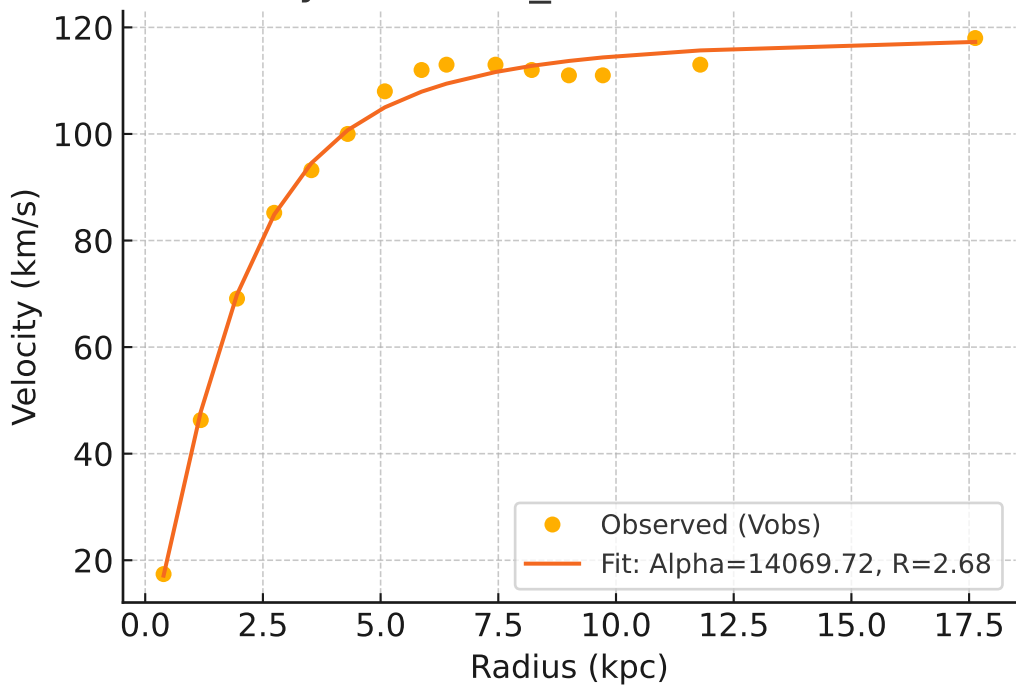
# Galaxy: F568-1\_rotmod ( $R^2=0.997$ )



# Galaxy: F568-3\_rotmod ( $R^2=0.978$ )

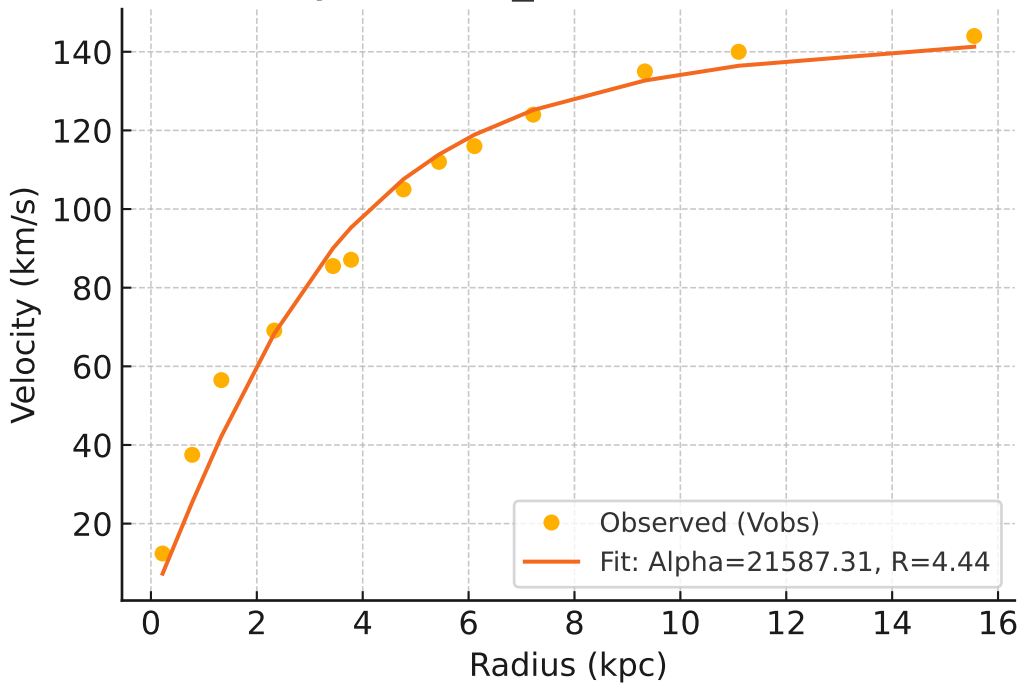


# Galaxy: F568-V1\_rotmod ( $R^2=0.994$ )

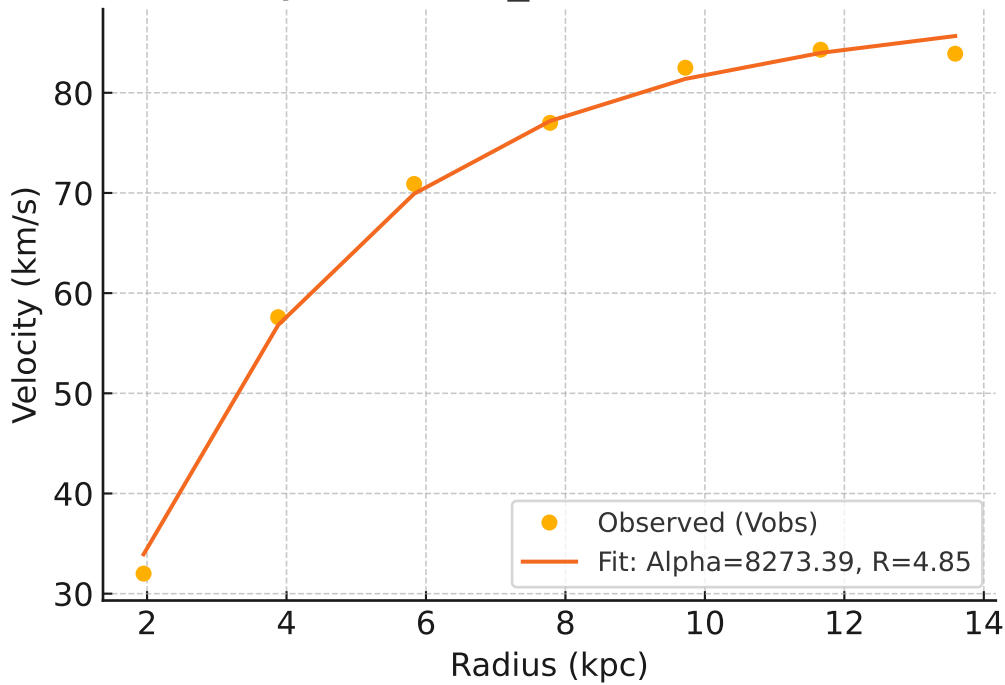




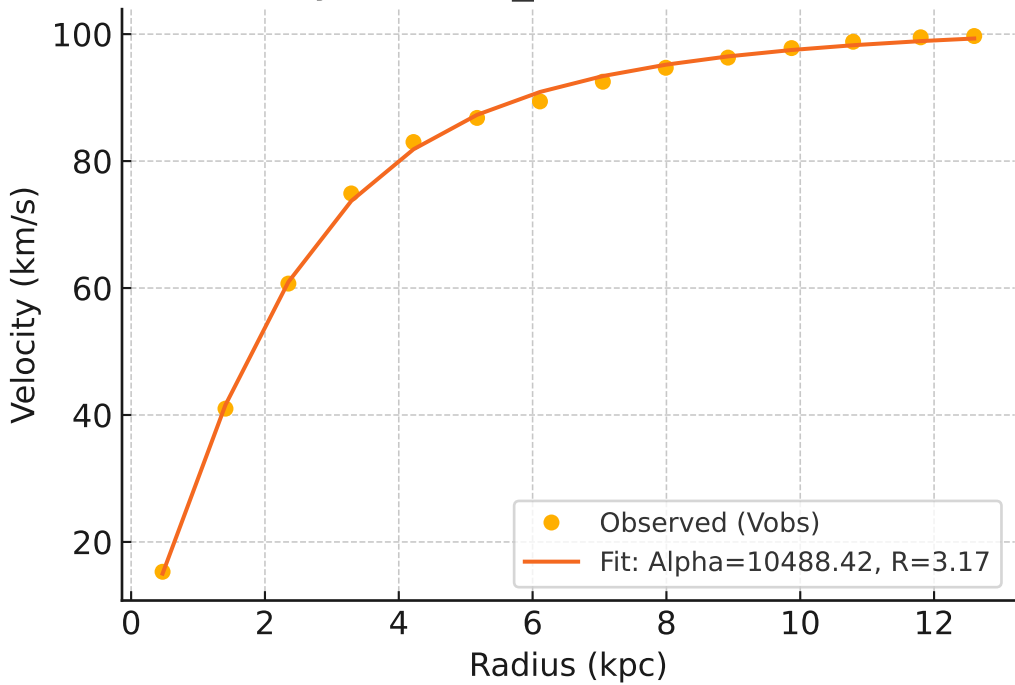
# Galaxy: F571-8\_rotmod ( $R^2=0.975$ )



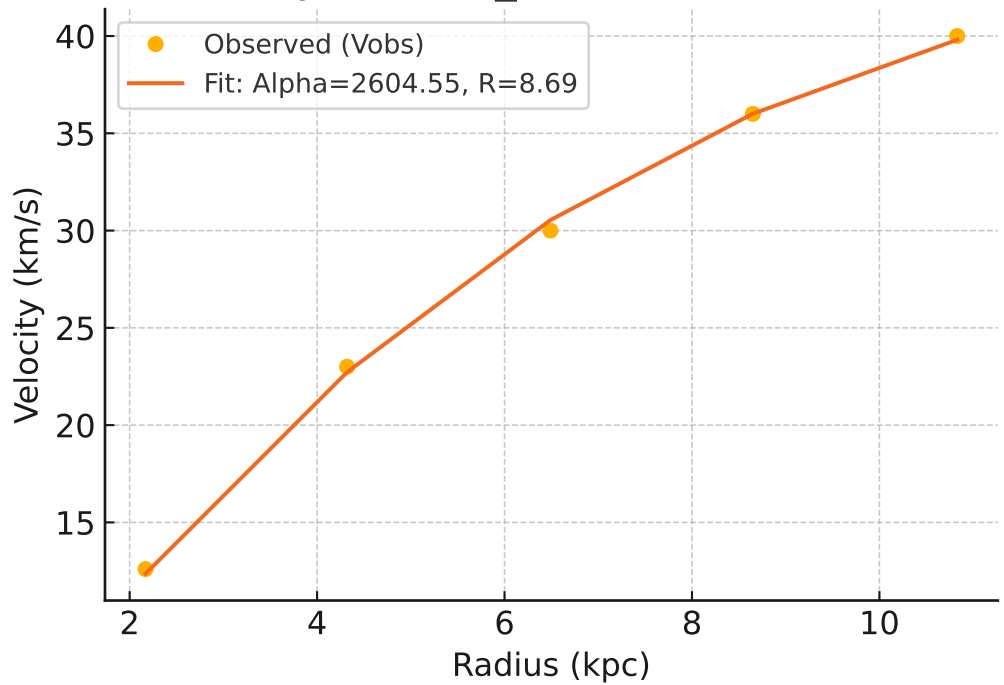
# Galaxy: F571-V1\_rotmod ( $R^2=0.996$ )



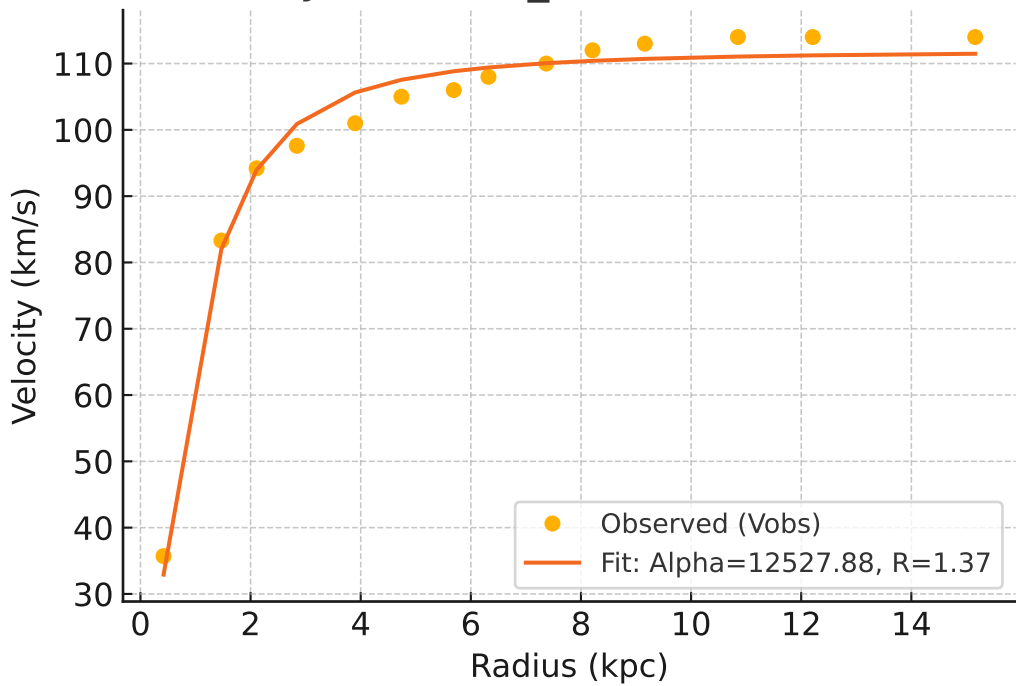
# Galaxy: F574-1\_rotmod ( $R^2=0.999$ )



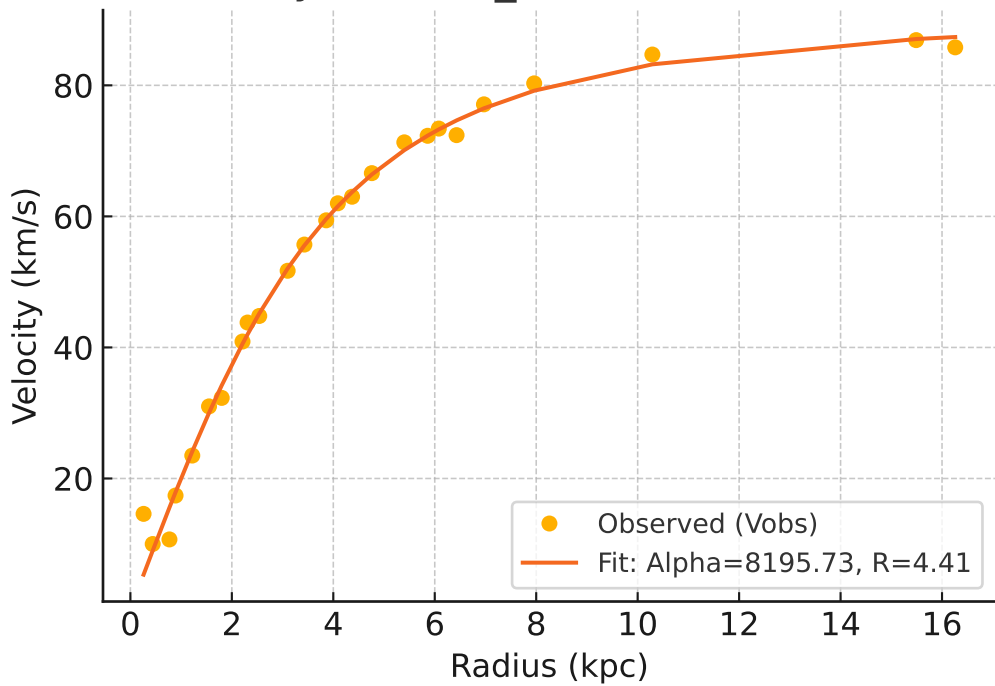
# Galaxy: F574-2\_rotmod ( $R^2=0.999$ )



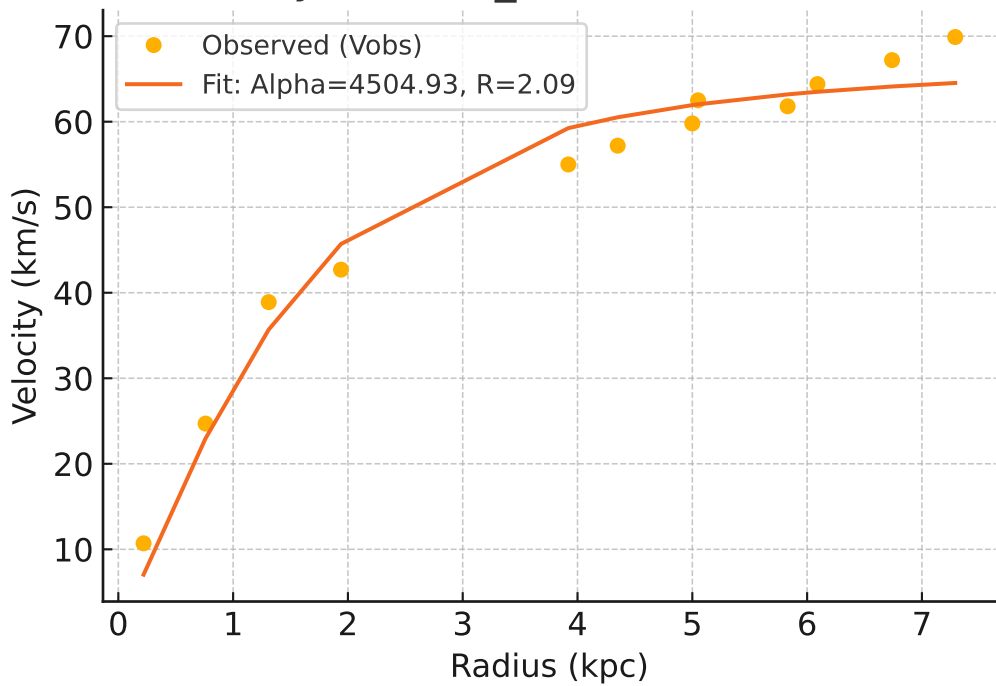
# Galaxy: F579-V1\_rotmod ( $R^2=0.984$ )



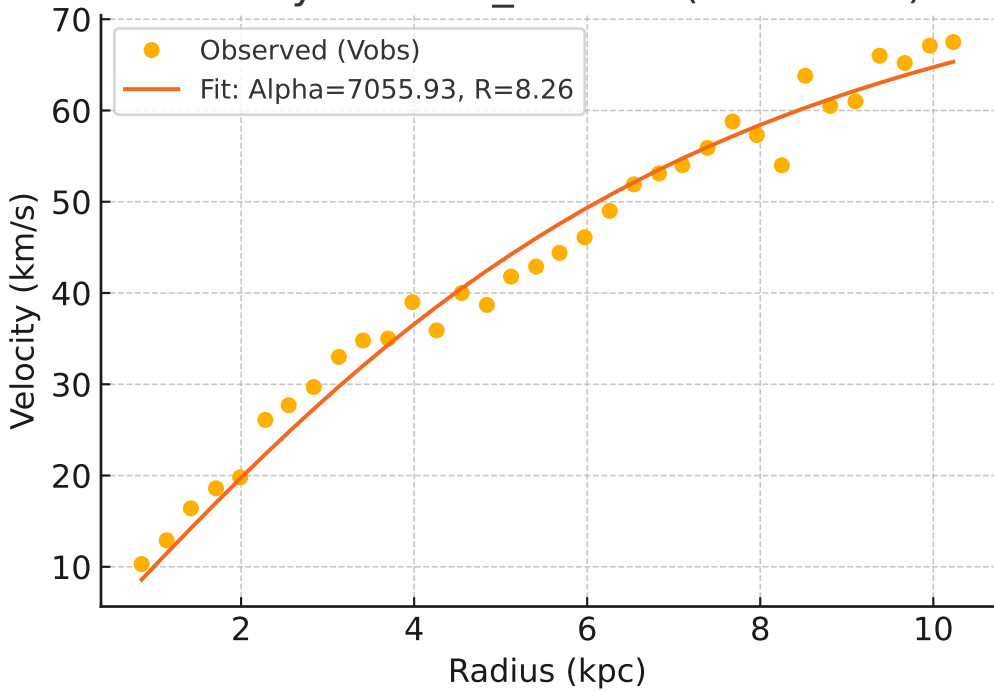
# Galaxy: F583-1\_rotmod ( $R^2=0.991$ )



# Galaxy: F583-4\_rotmod ( $R^2=0.970$ )

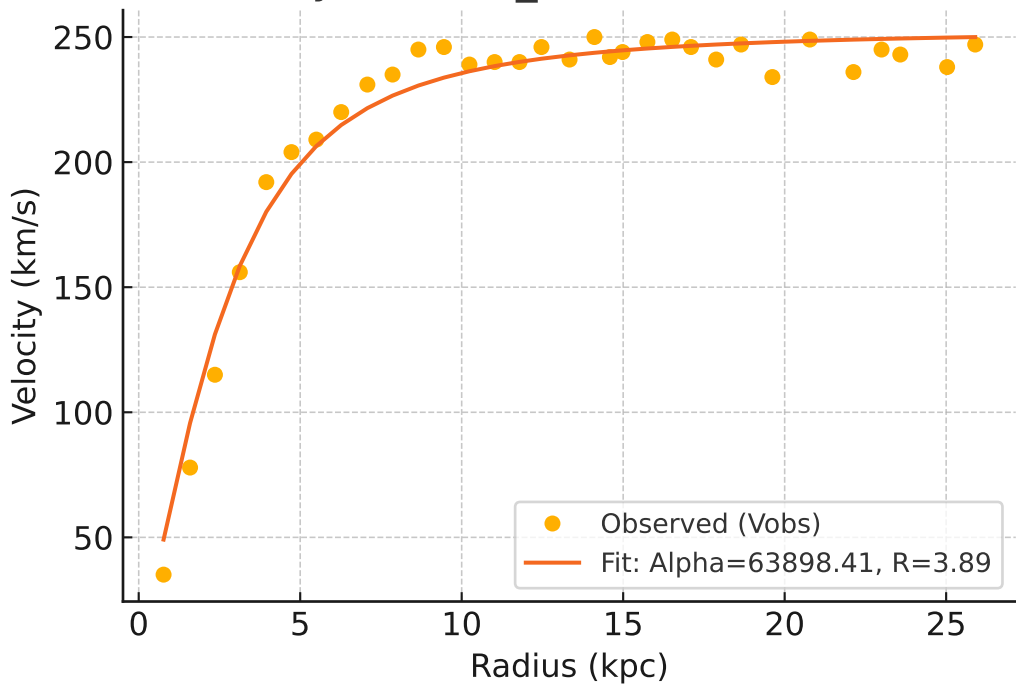


# Galaxy: IC2574\_rotmod ( $R^2=0.979$ )

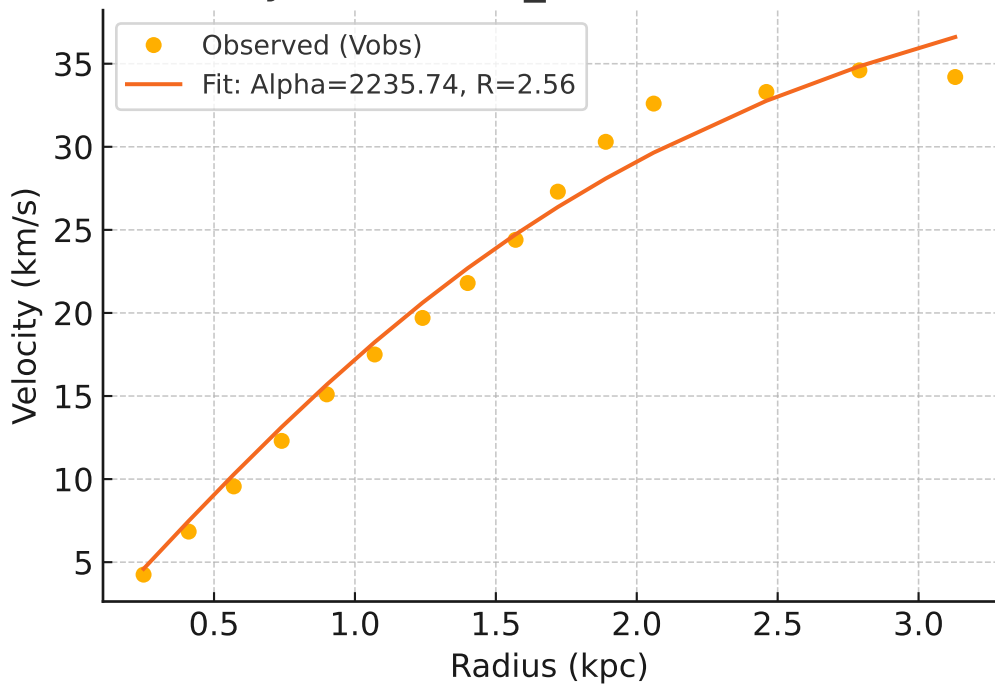




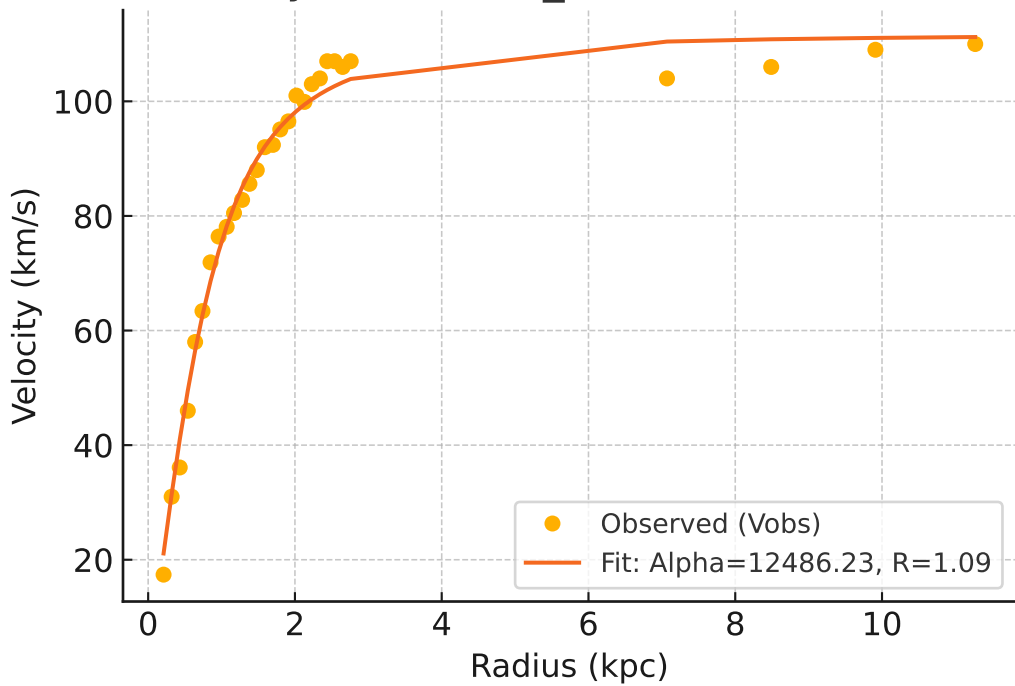
# Galaxy: IC4202\_rotmod ( $R^2=0.973$ )



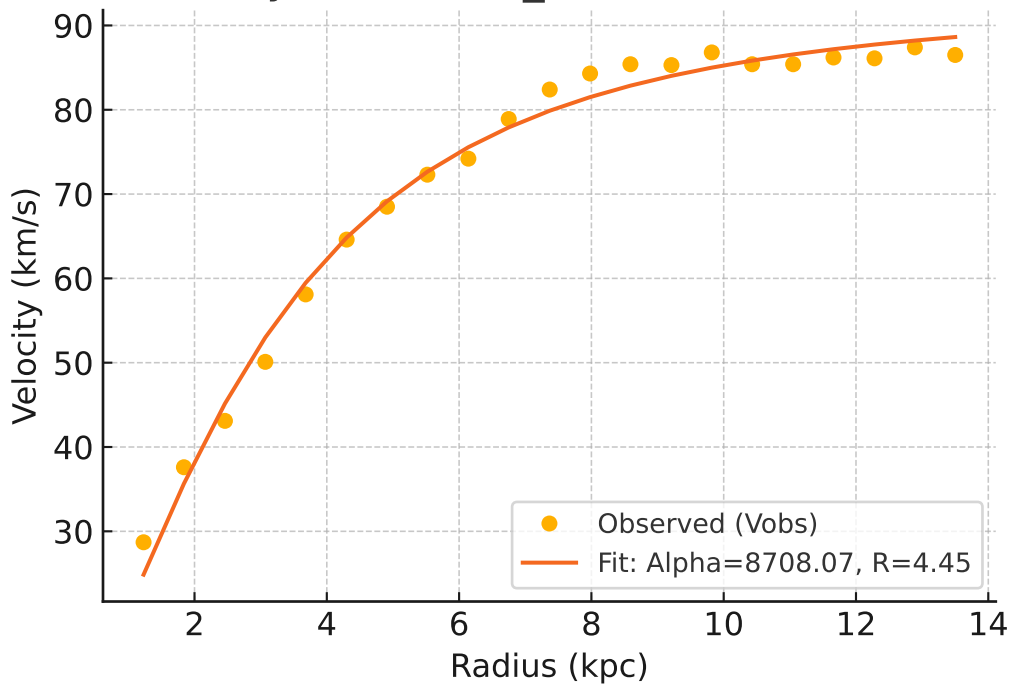
# Galaxy: KK98-251\_rotmod ( $R^2=0.984$ )



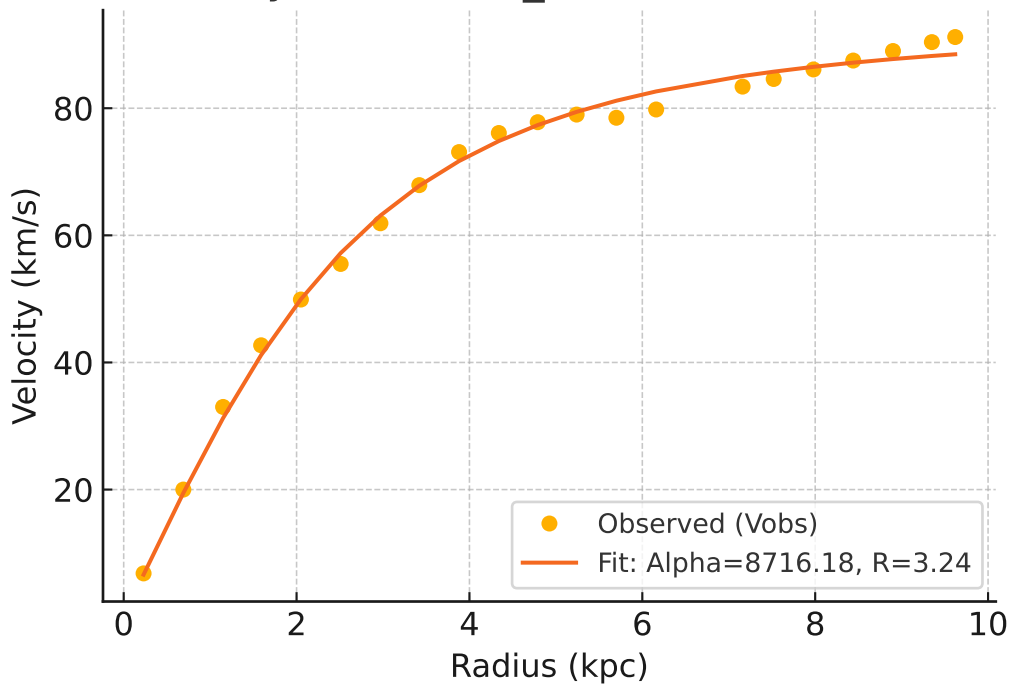
# Galaxy: NGC0024\_rotmod ( $R^2=0.987$ )



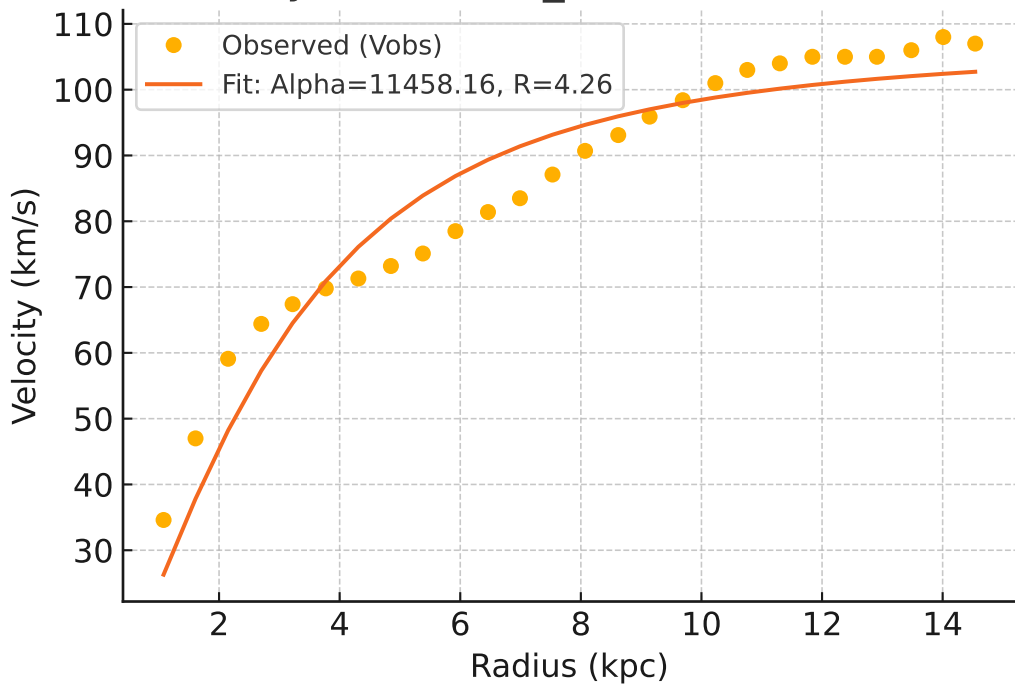
# Galaxy: NGC0055\_rotmod ( $R^2=0.989$ )



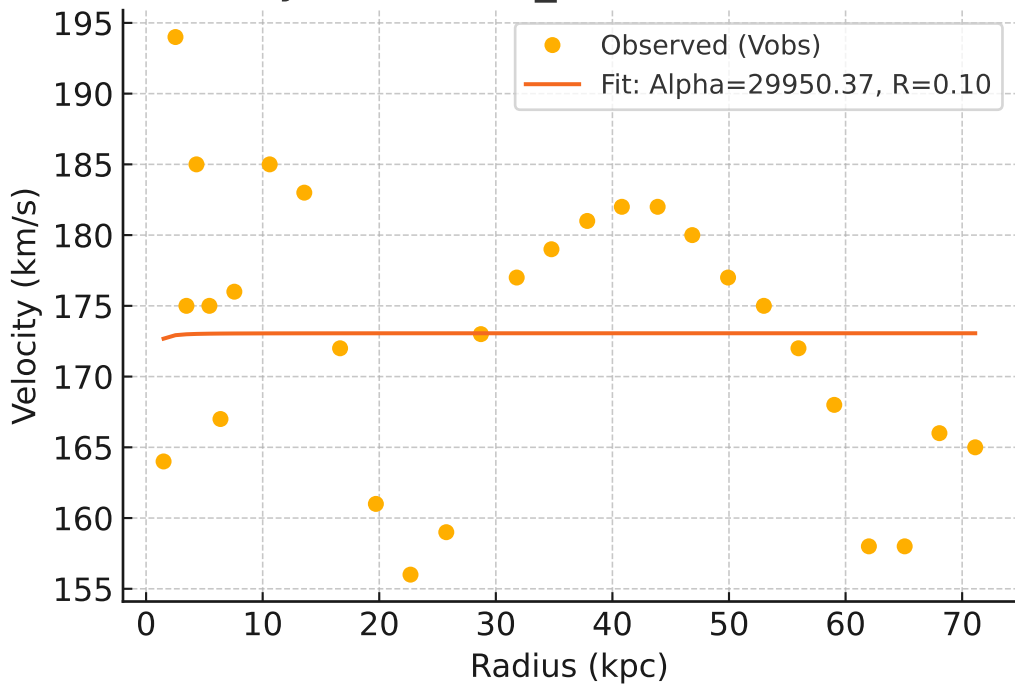
# Galaxy: NGC0100\_rotmod ( $R^2=0.996$ )



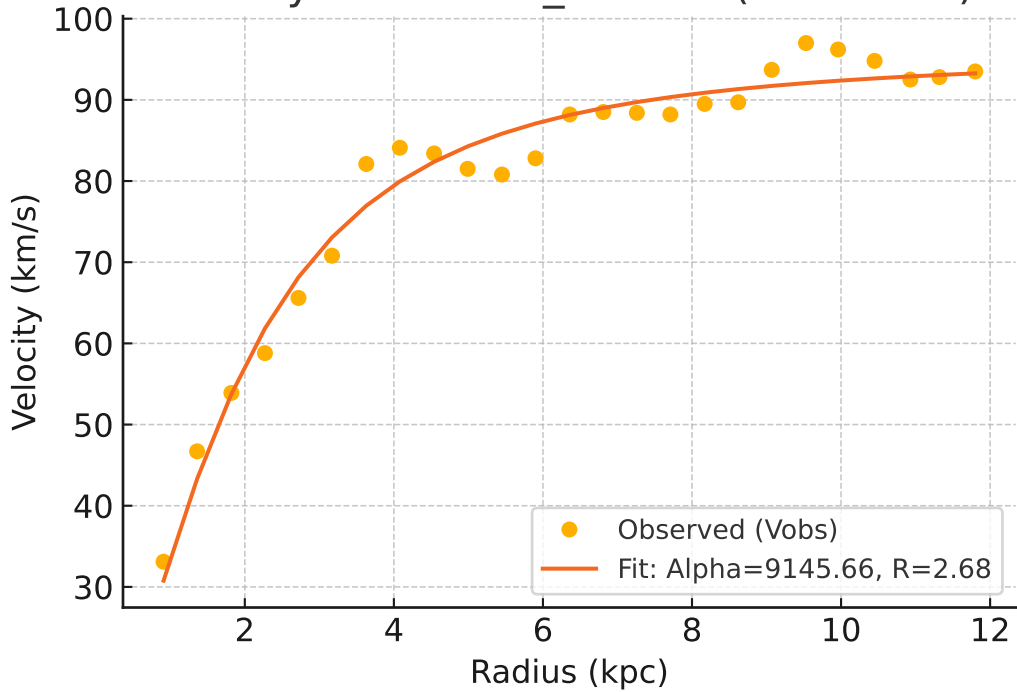
# Galaxy: NGC0247\_rotmod ( $R^2=0.913$ )



# Galaxy: NGC0289\_rotmod ( $R^2 = -0.000$ )

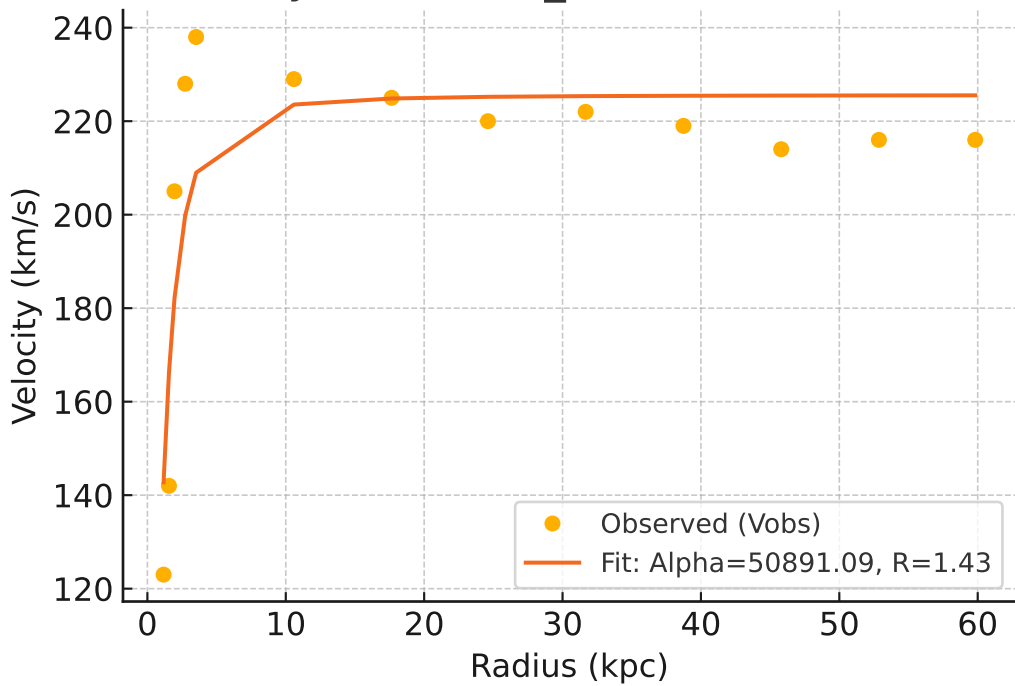


# Galaxy: NGC0300\_rotmod ( $R^2=0.971$ )

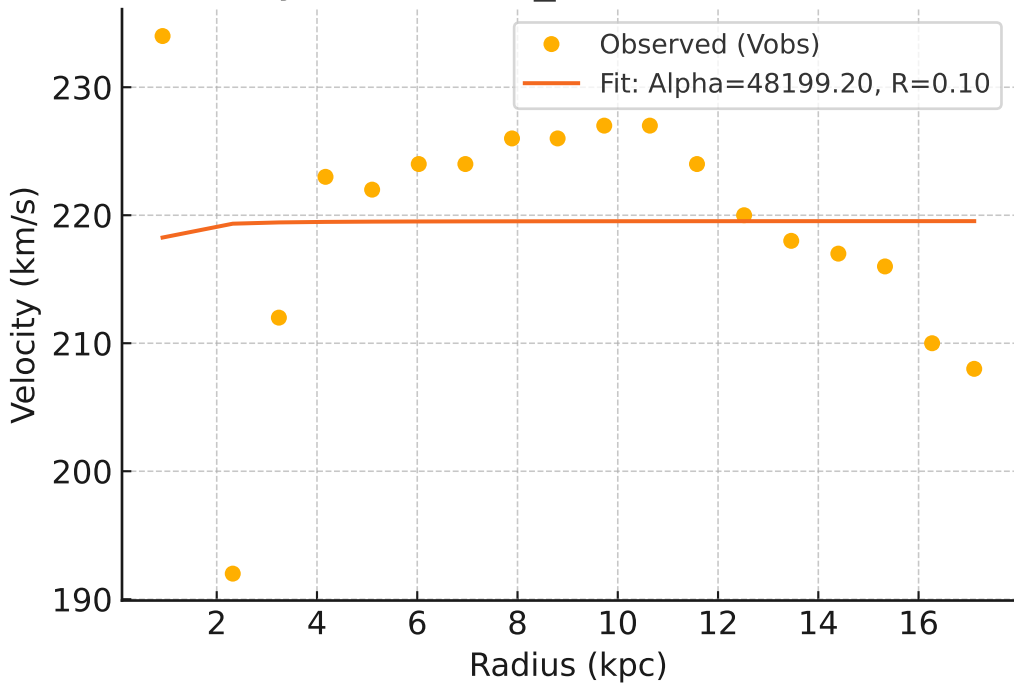




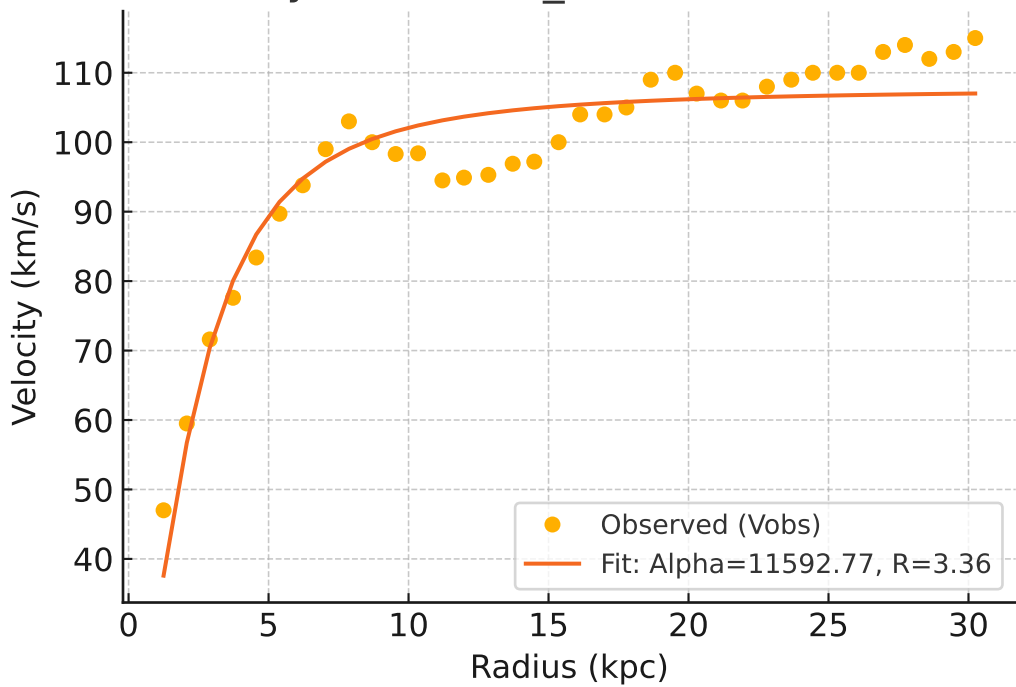
# Galaxy: NGC0801\_rotmod ( $R^2=0.750$ )



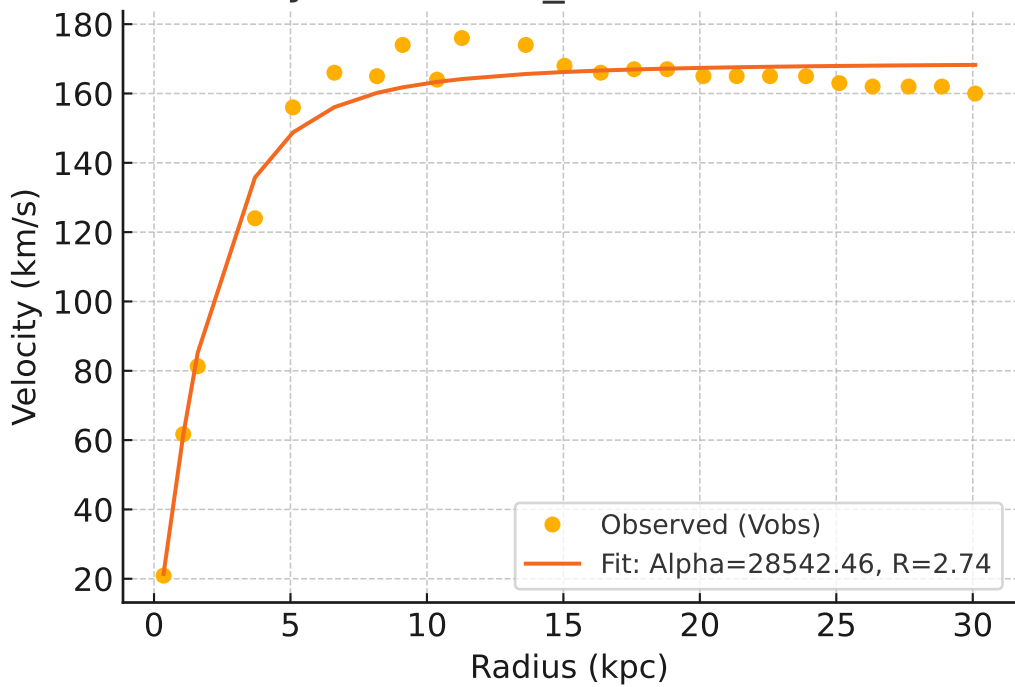
# Galaxy: NGC0891\_rotmod ( $R^2 = -0.018$ )



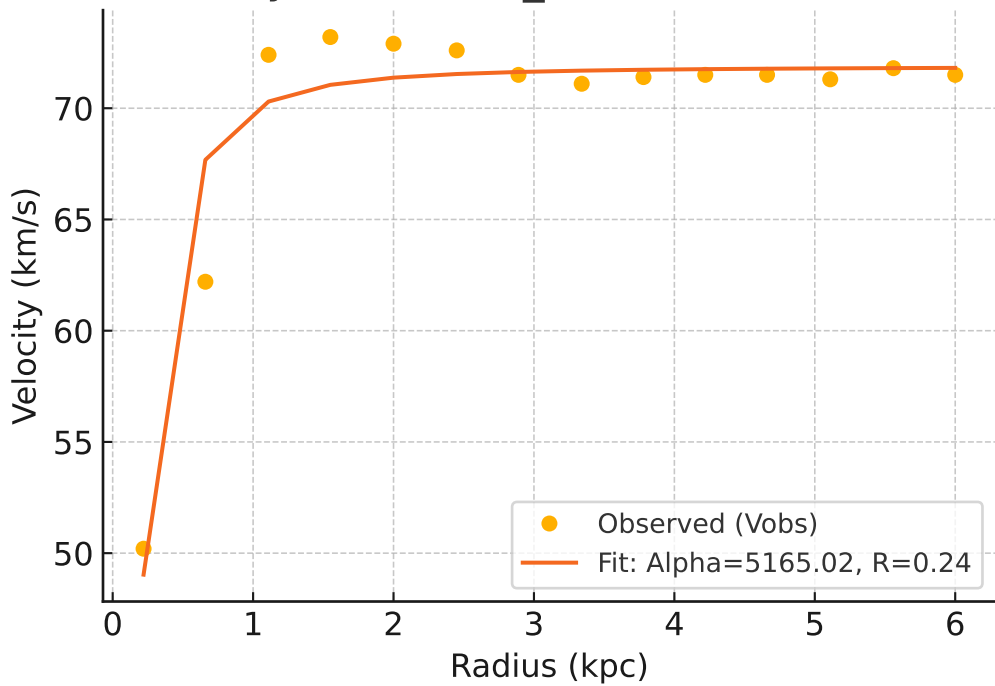
# Galaxy: NGC1003\_rotmod ( $R^2=0.896$ )



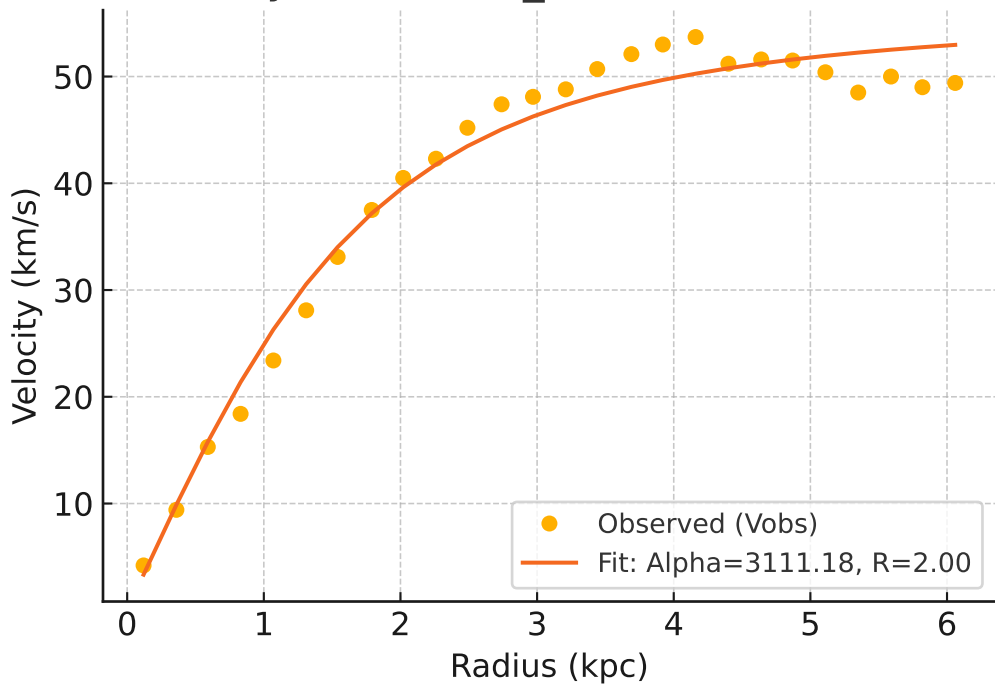
# Galaxy: NGC1090\_rotmod ( $R^2=0.974$ )



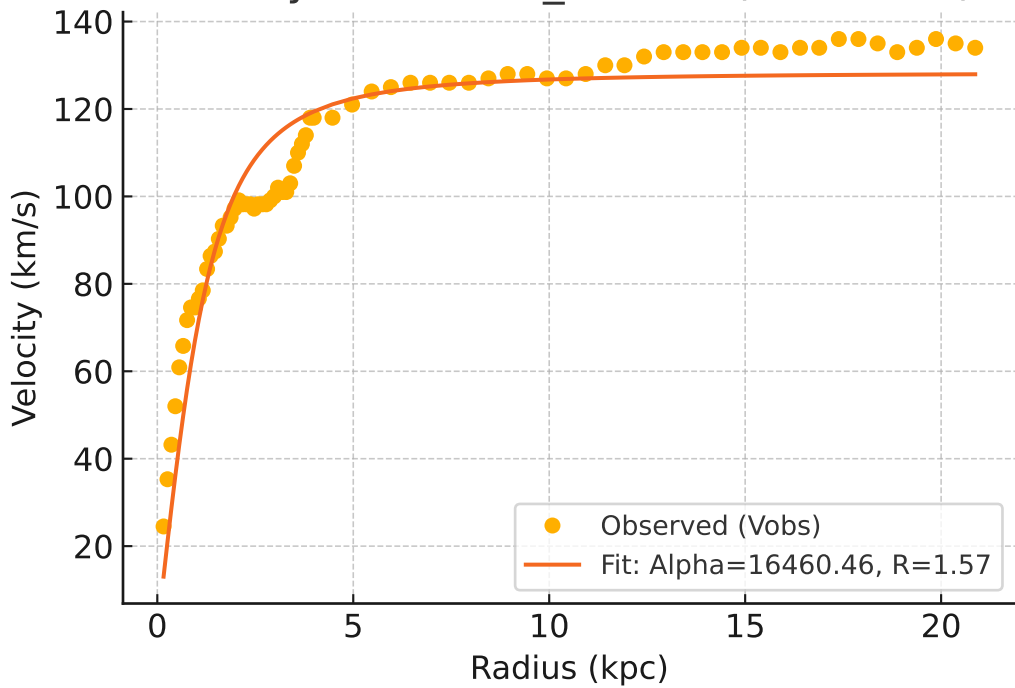
# Galaxy: NGC1705\_rotmod ( $R^2=0.910$ )



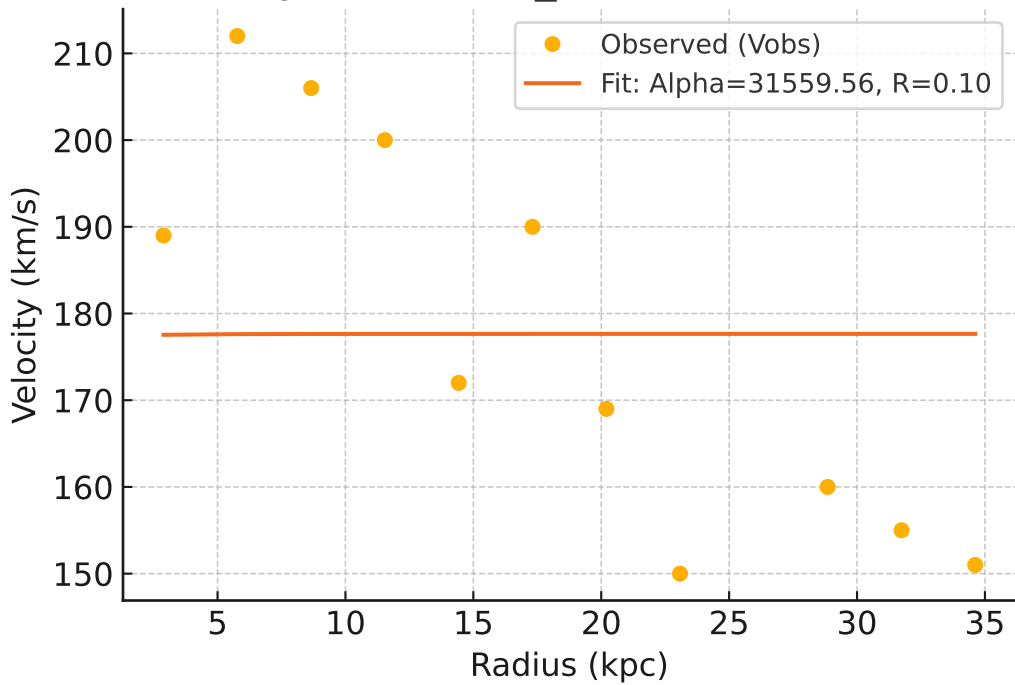
# Galaxy: NGC2366\_rotmod ( $R^2=0.976$ )



# Galaxy: NGC2403\_rotmod ( $R^2=0.905$ )

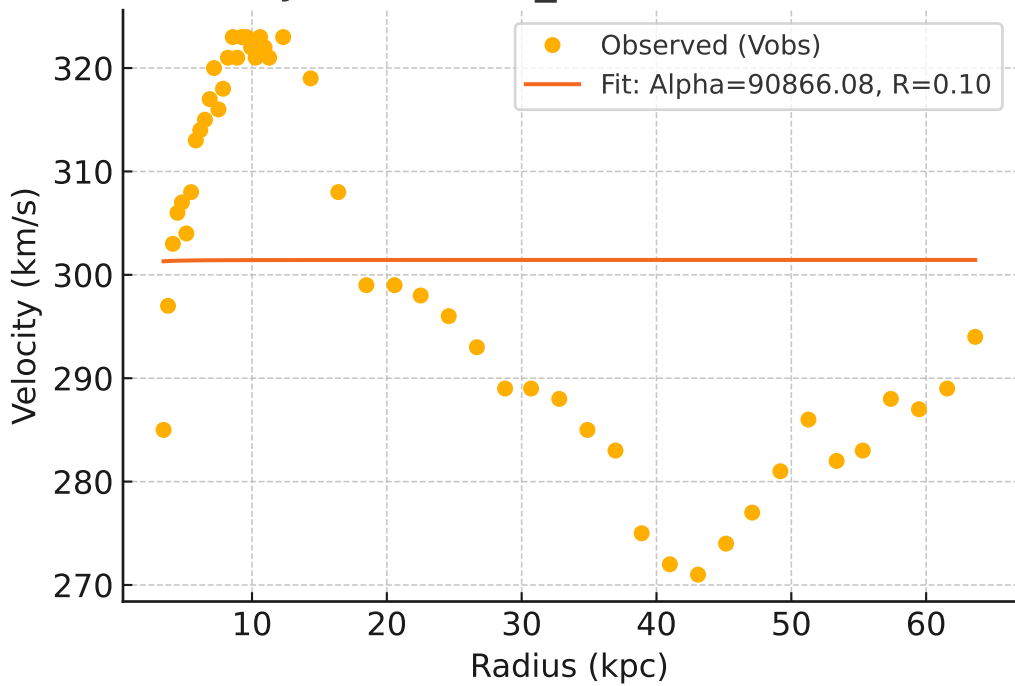


# Galaxy: NGC2683\_rotmod ( $R^2 = -0.001$ )

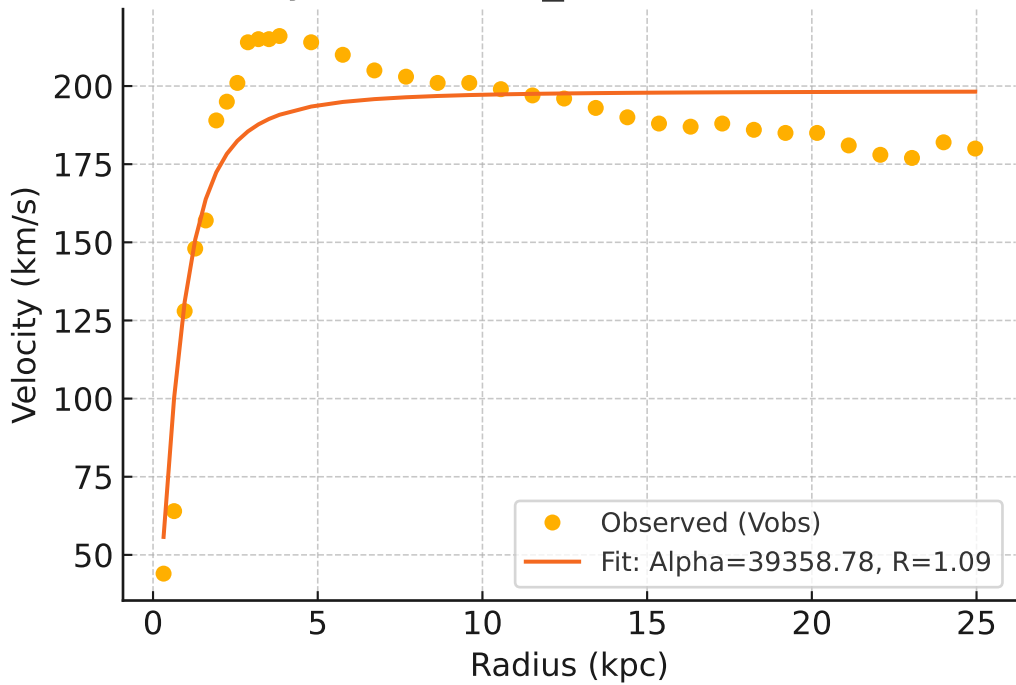




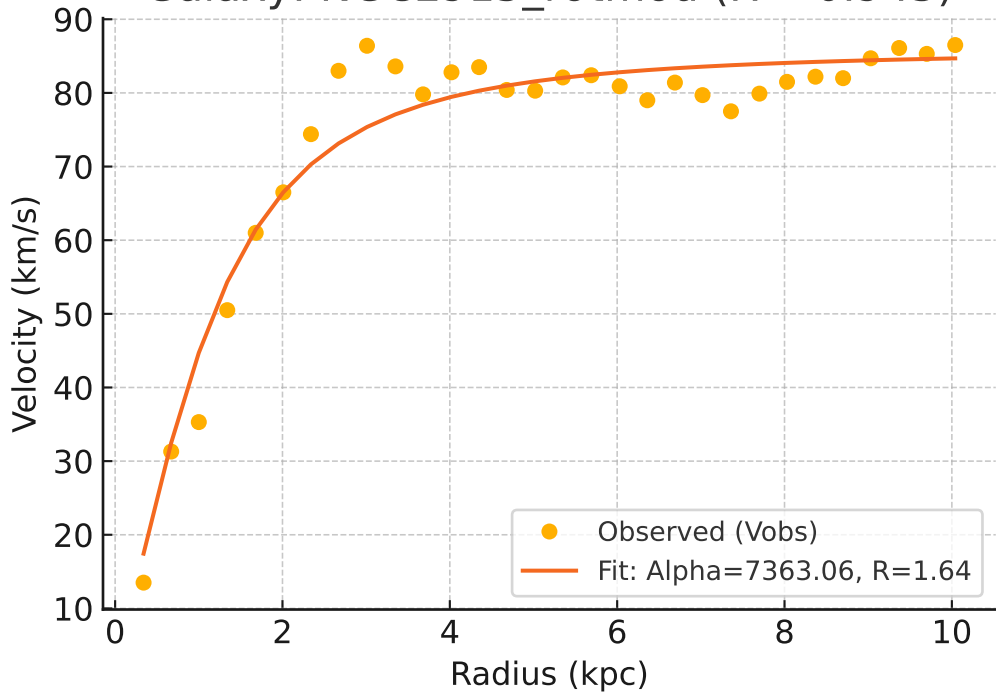
# Galaxy: NGC2841\_rotmod ( $R^2 = -0.001$ )



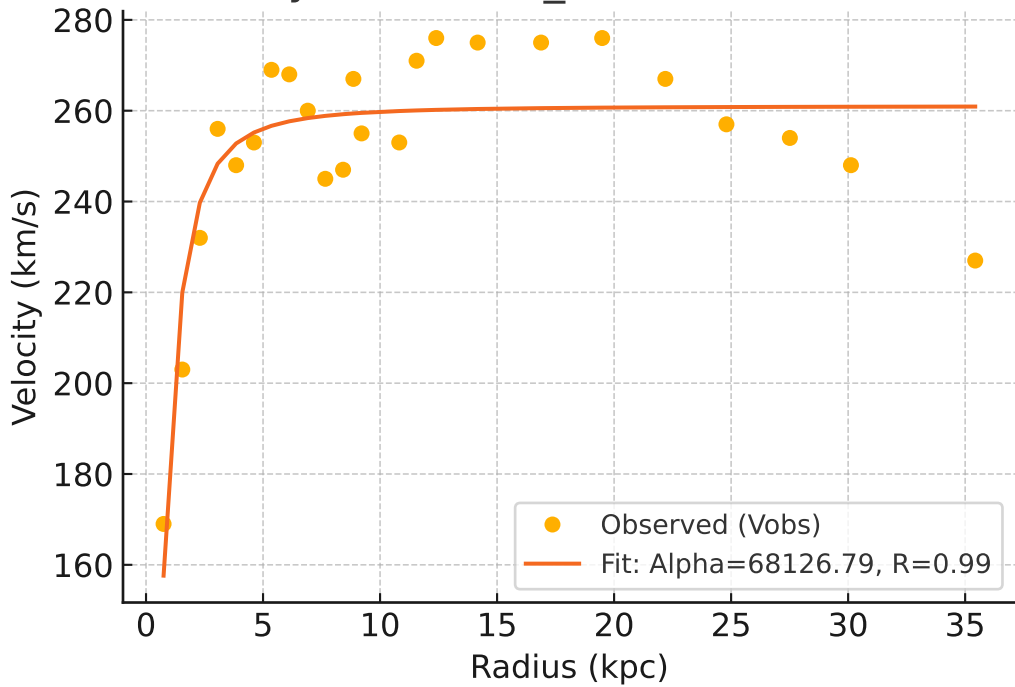
# Galaxy: NGC2903\_rotmod ( $R^2=0.815$ )



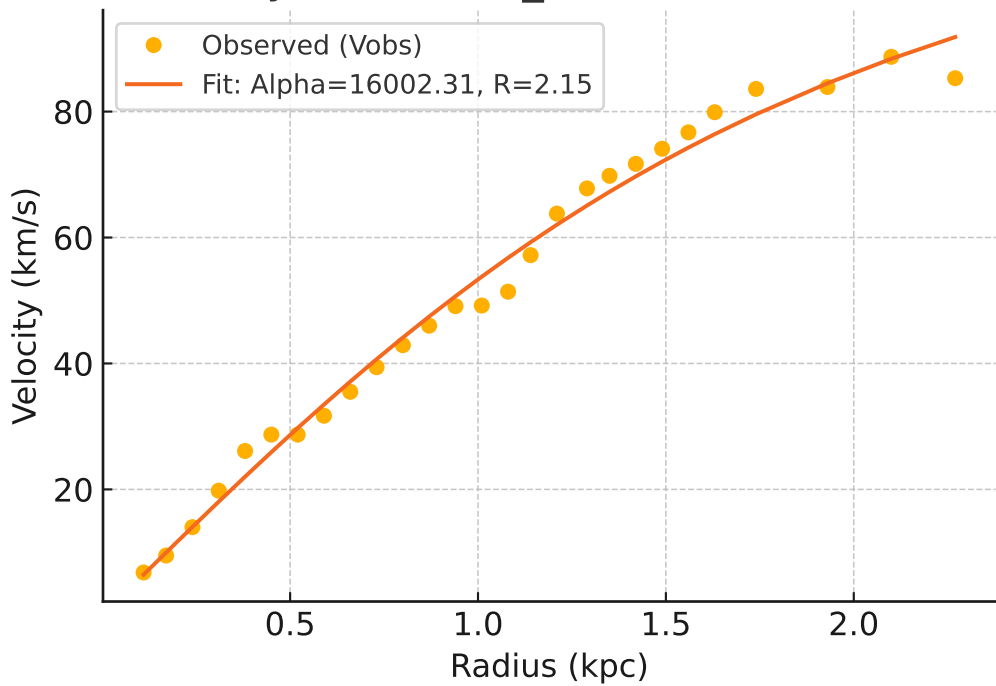
# Galaxy: NGC2915\_rotmod ( $R^2=0.943$ )



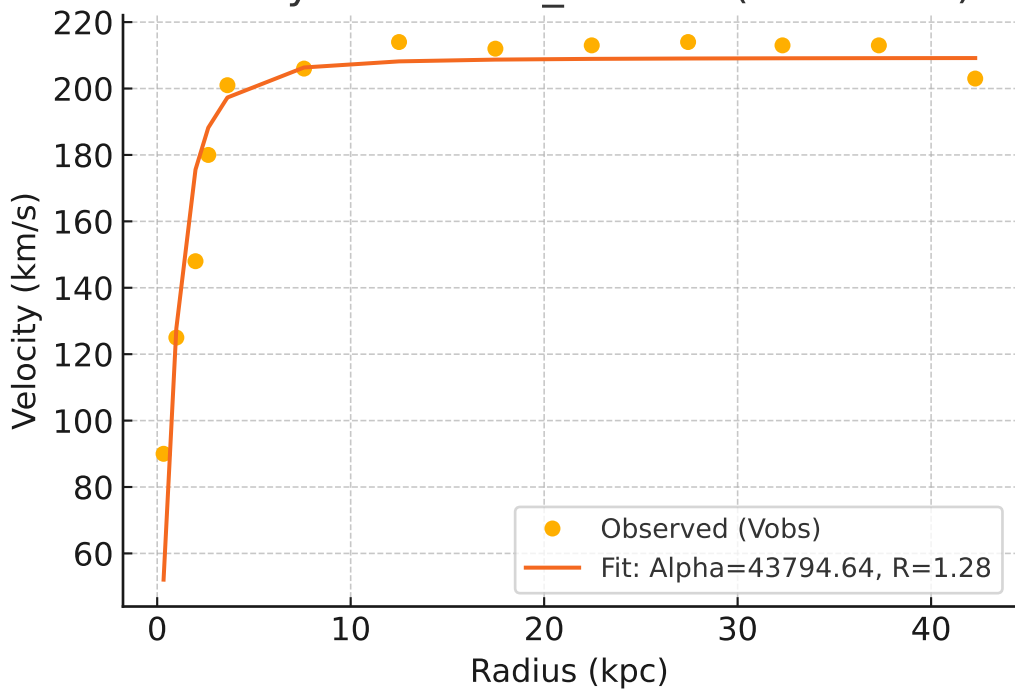
# Galaxy: NGC2955\_rotmod ( $R^2=0.735$ )



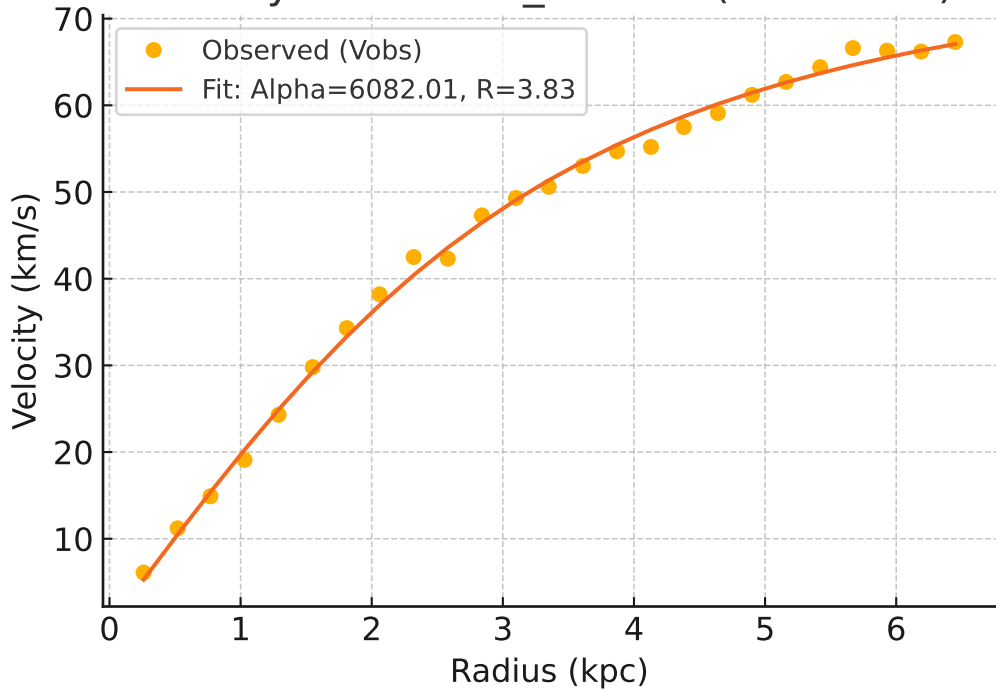
# Galaxy: NGC2976\_rotmod ( $R^2=0.988$ )



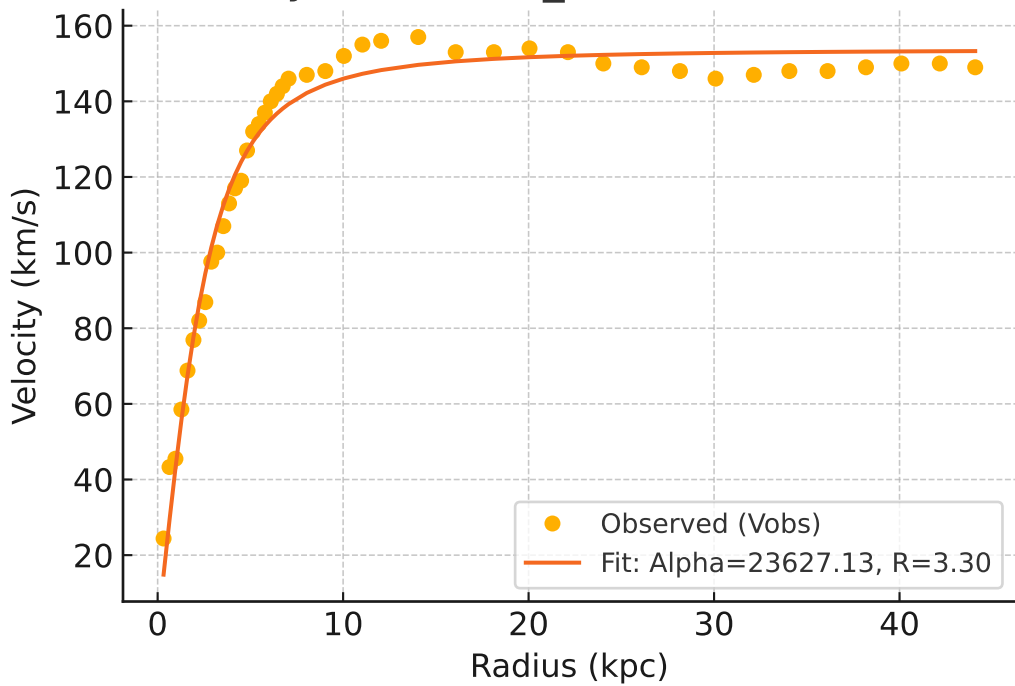
# Galaxy: NGC2998\_rotmod ( $R^2=0.876$ )



# Galaxy: NGC3109\_rotmod ( $R^2=0.997$ )

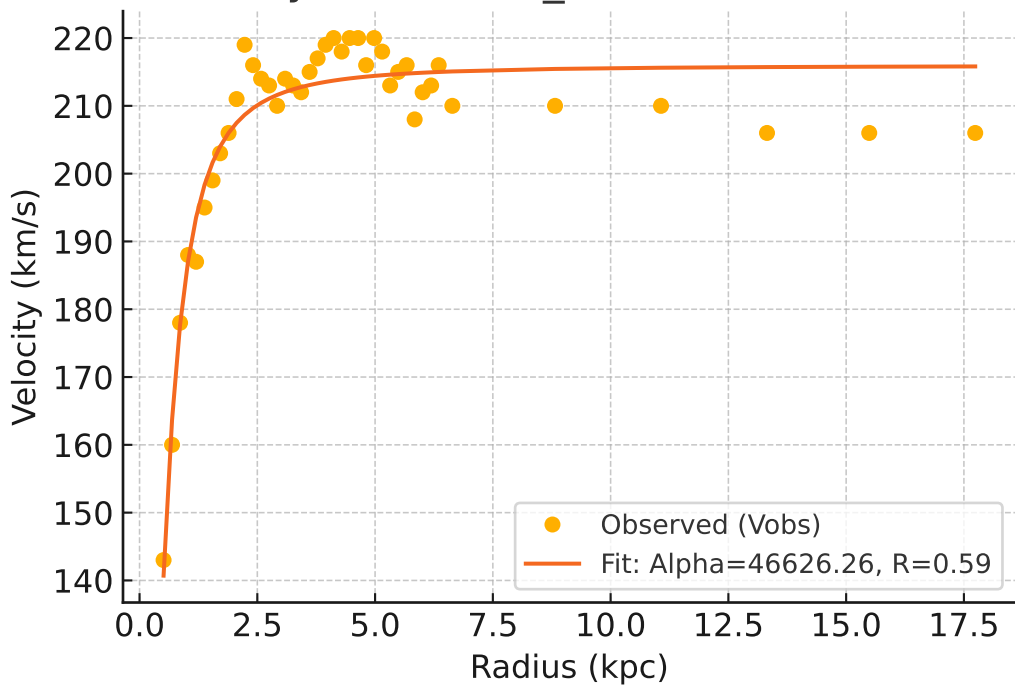


# Galaxy: NGC3198\_rotmod ( $R^2=0.978$ )

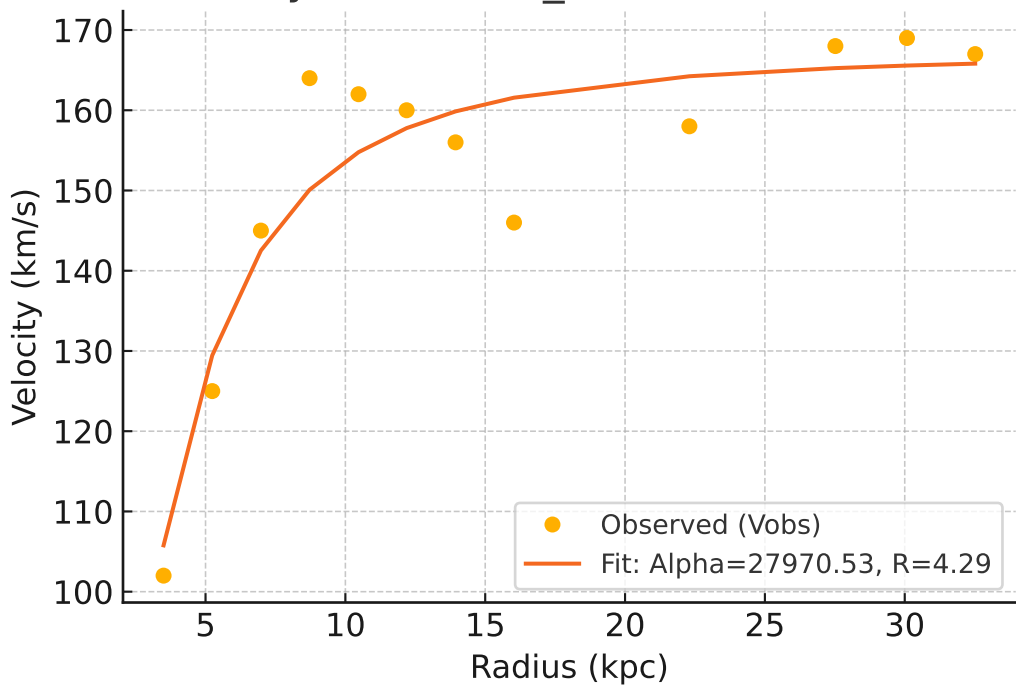




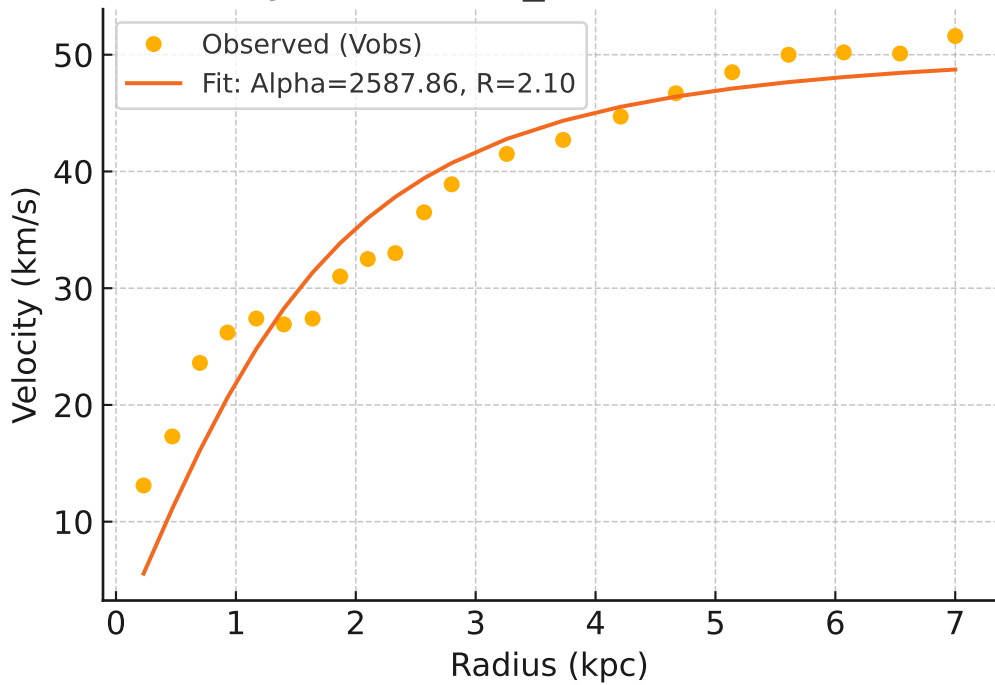
# Galaxy: NGC3521\_rotmod ( $R^2=0.910$ )



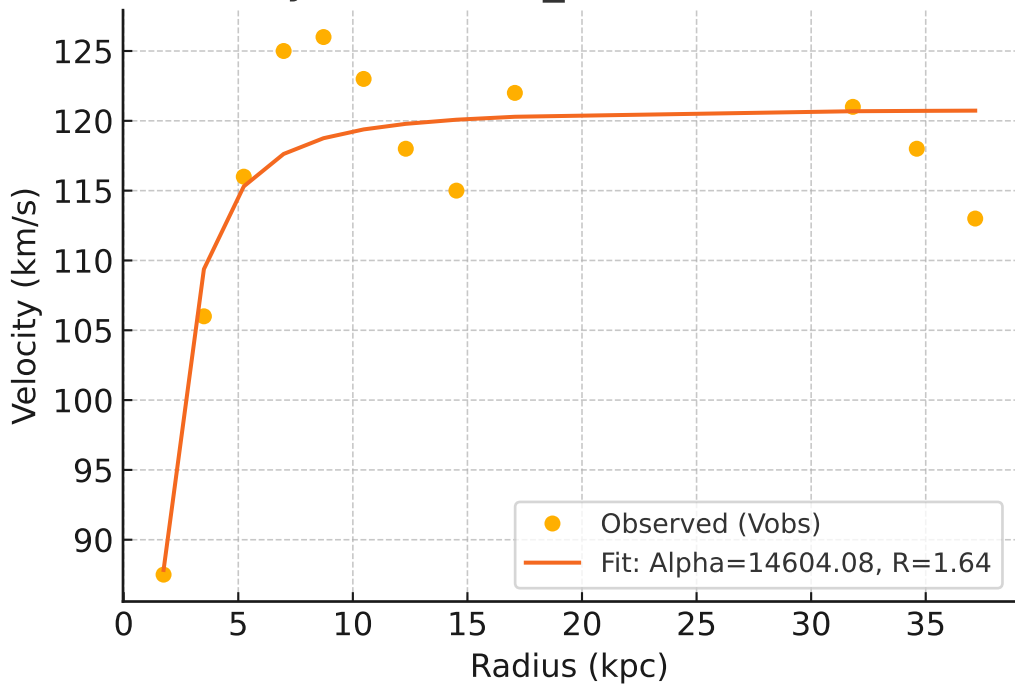
# Galaxy: NGC3726\_rotmod ( $R^2=0.863$ )



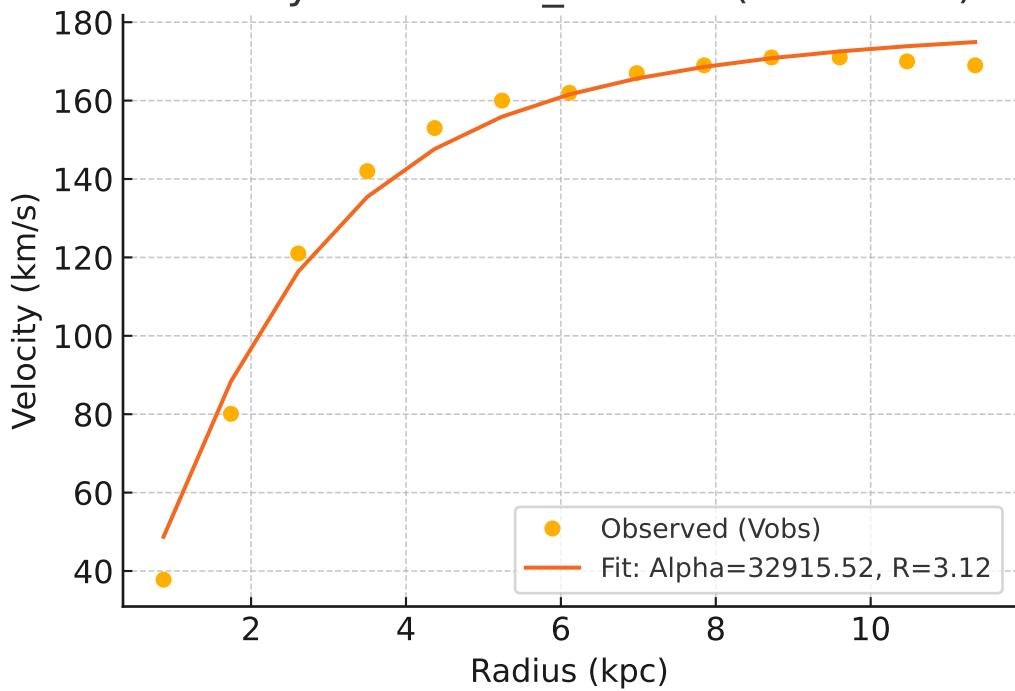
# Galaxy: NGC3741\_rotmod ( $R^2=0.891$ )



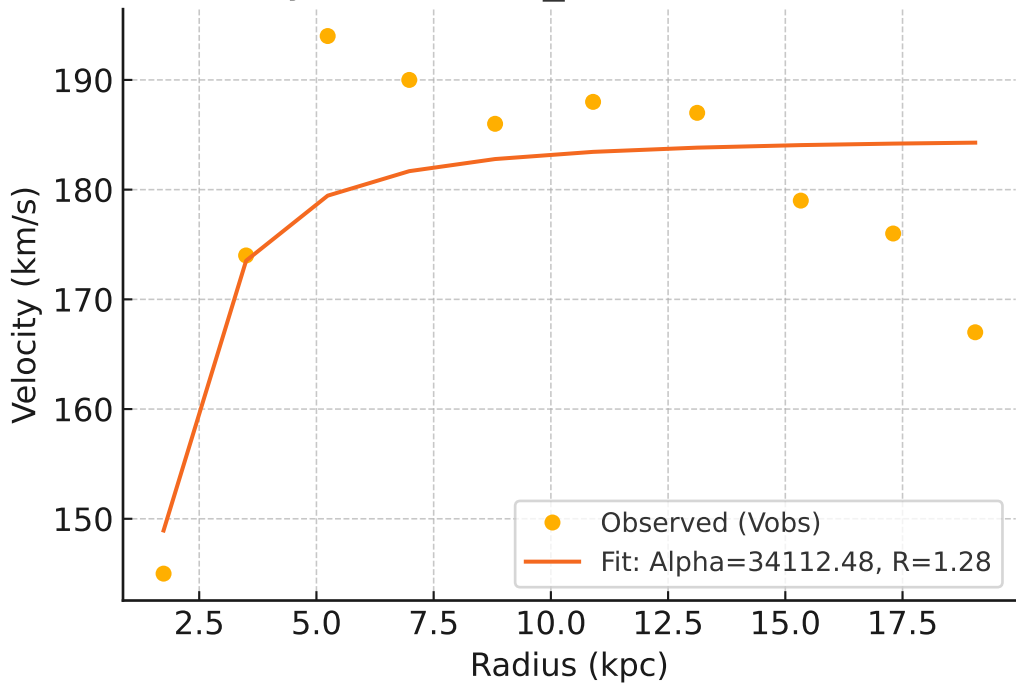
# Galaxy: NGC3769\_rotmod ( $R^2=0.811$ )



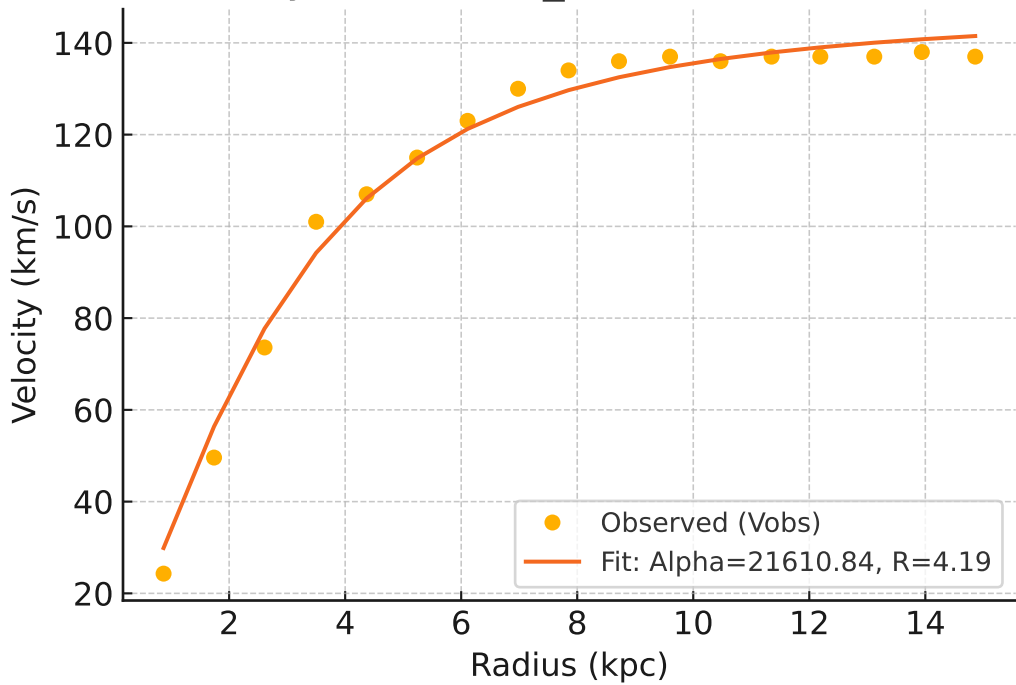
# Galaxy: NGC3877\_rotmod ( $R^2=0.983$ )



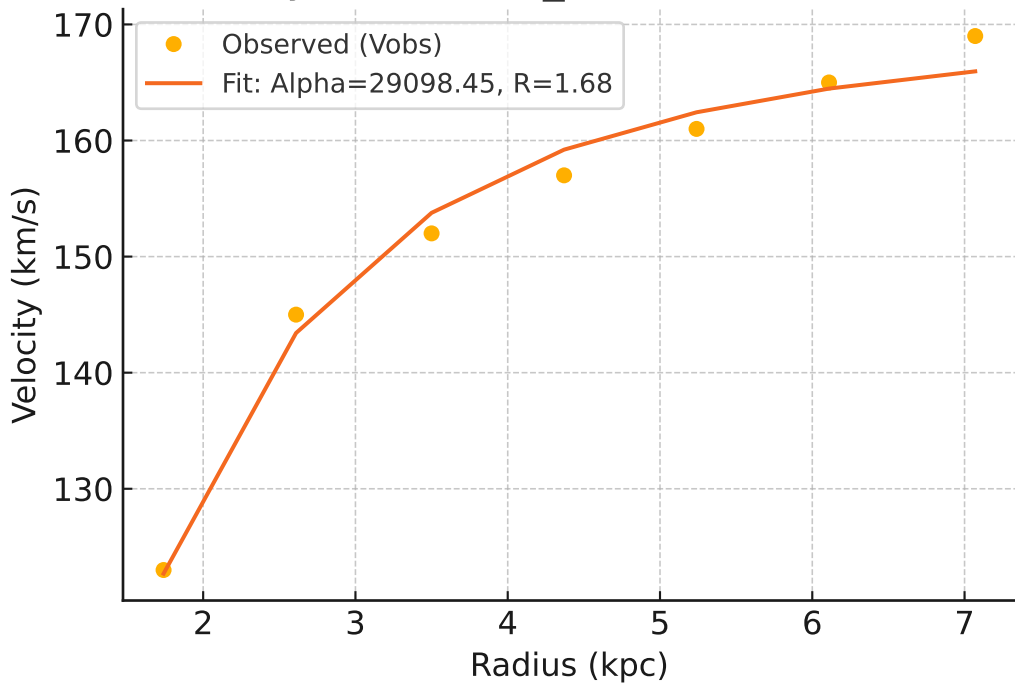
# Galaxy: NGC3893\_rotmod ( $R^2=0.611$ )



# Galaxy: NGC3917\_rotmod ( $R^2=0.987$ )

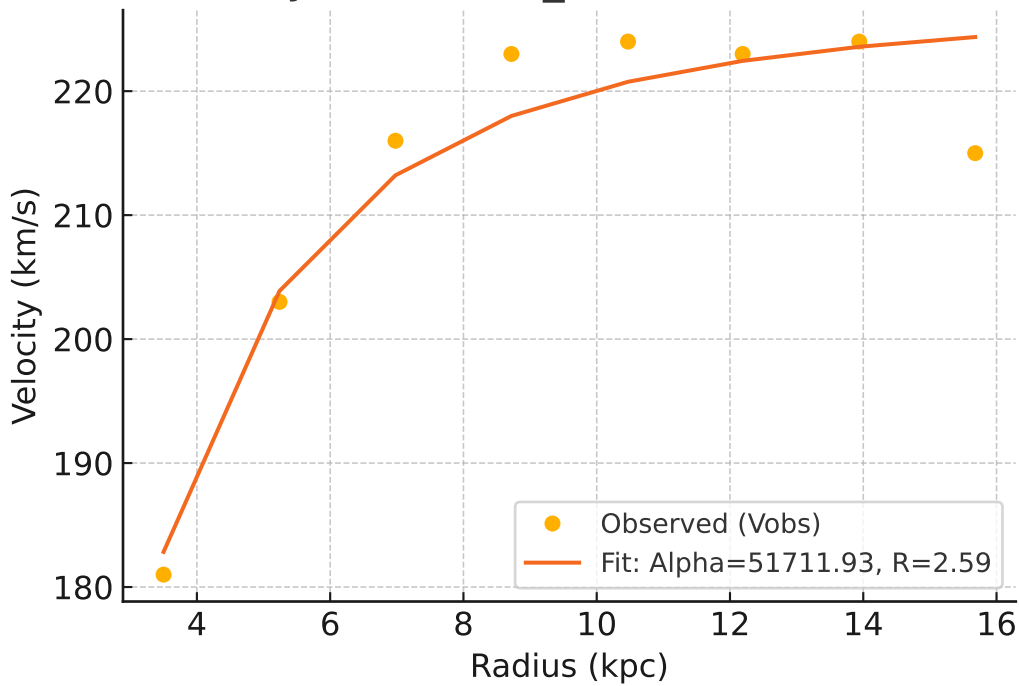


# Galaxy: NGC3949\_rotmod ( $R^2=0.985$ )

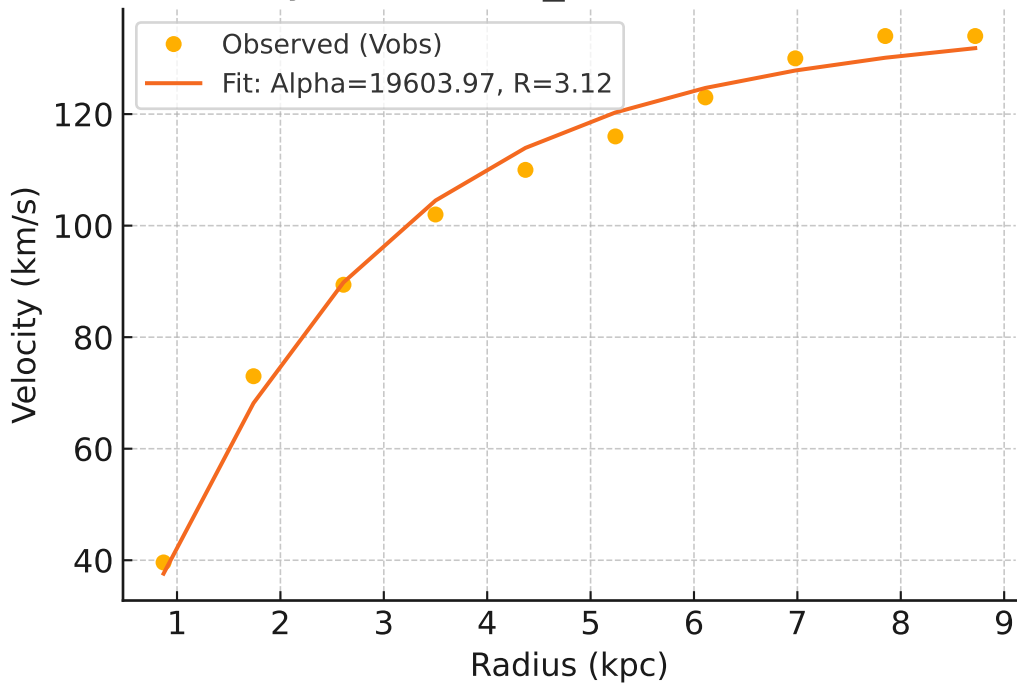




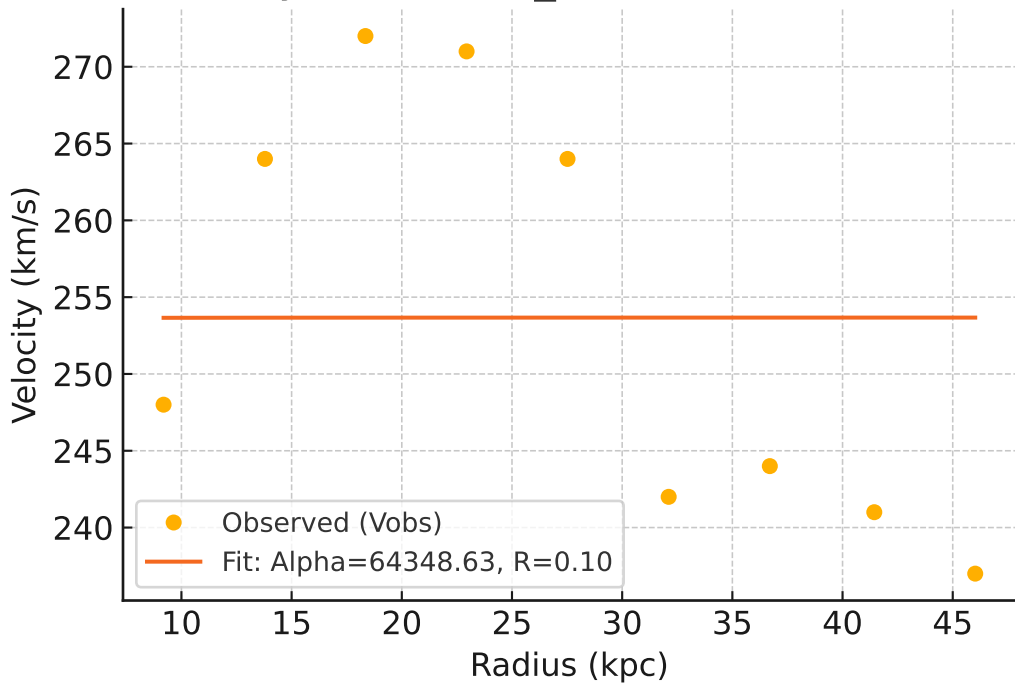
# Galaxy: NGC3953\_rotmod ( $R^2=0.914$ )



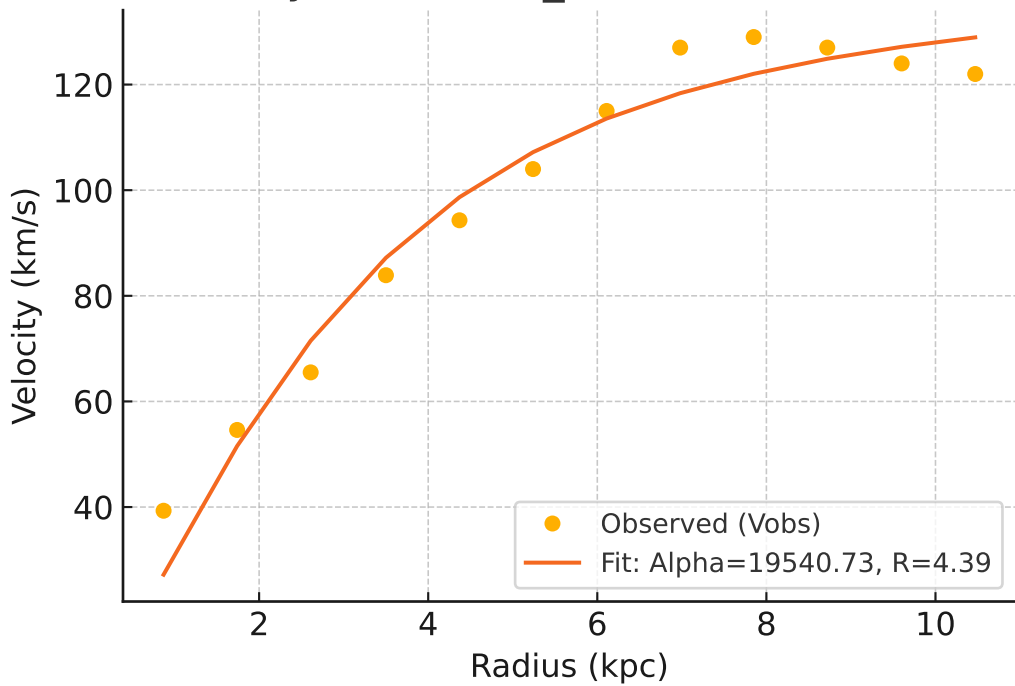
# Galaxy: NGC3972\_rotmod ( $R^2=0.989$ )



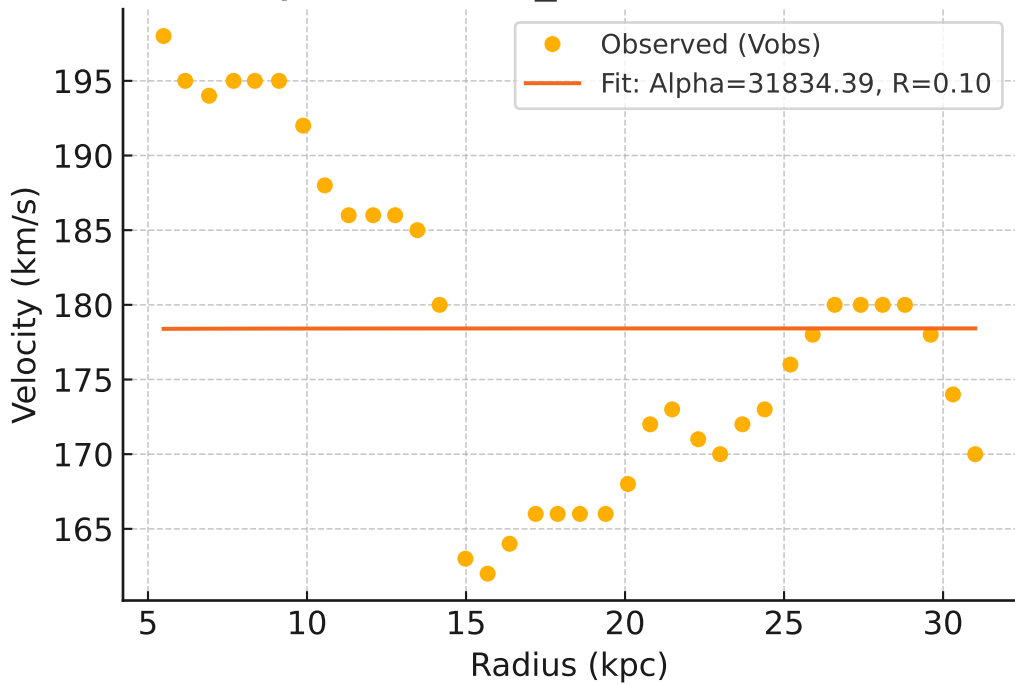
# Galaxy: NGC3992\_rotmod ( $R^2 = -0.000$ )



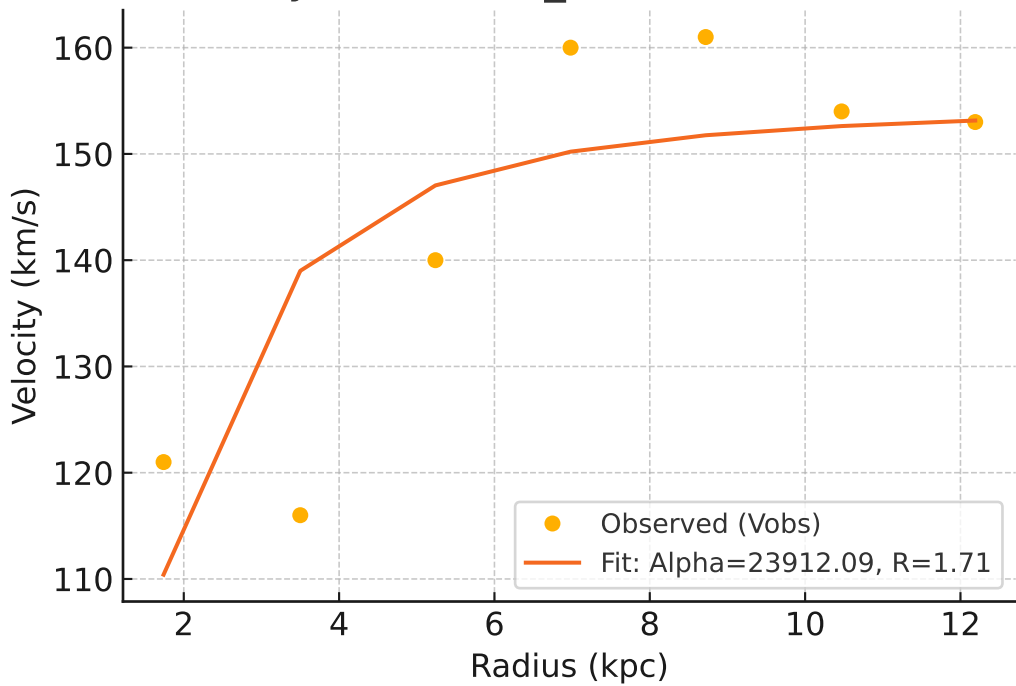
# Galaxy: NGC4010\_rotmod ( $R^2=0.961$ )



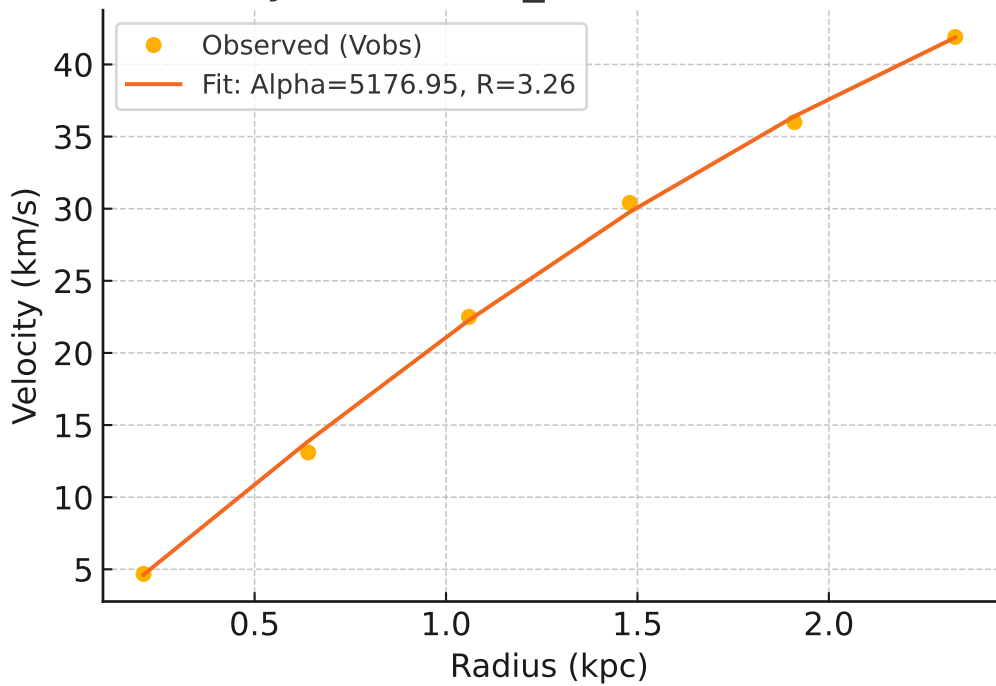
# Galaxy: NGC4013\_rotmod ( $R^2=-0.001$ )



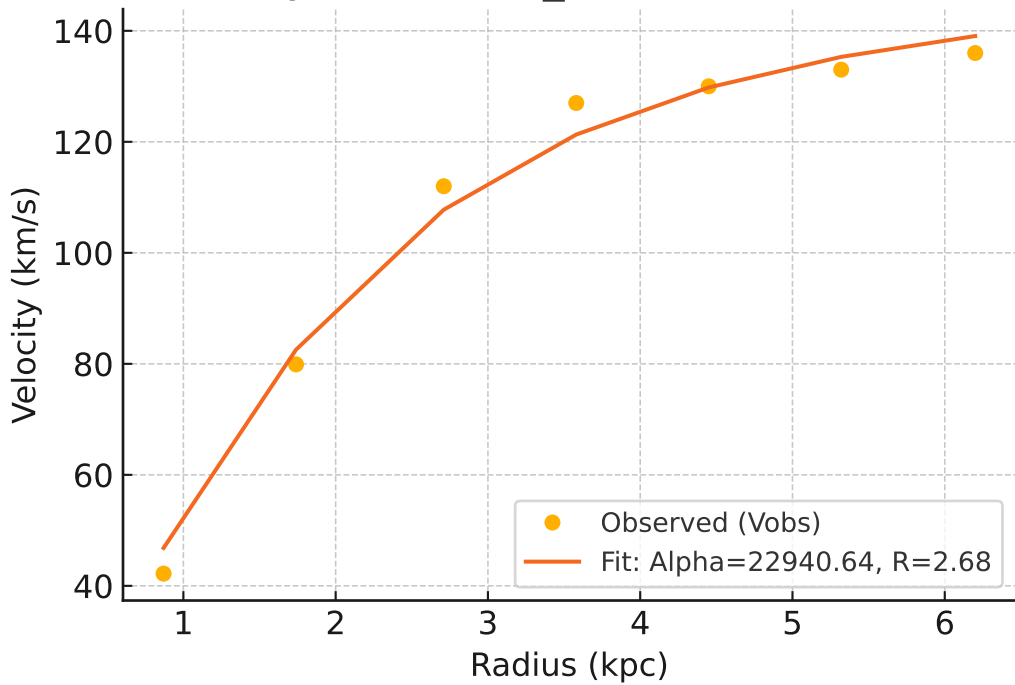
# Galaxy: NGC4051\_rotmod ( $R^2=0.575$ )



# Galaxy: NGC4068\_rotmod ( $R^2=0.999$ )

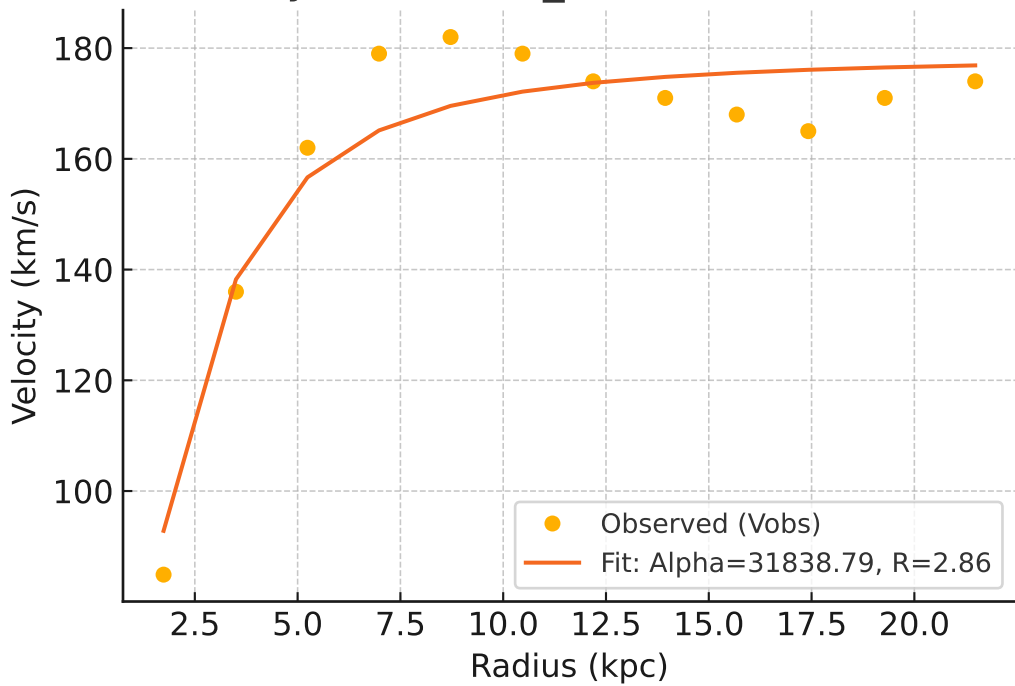


# Galaxy: NGC4085\_rotmod ( $R^2=0.987$ )

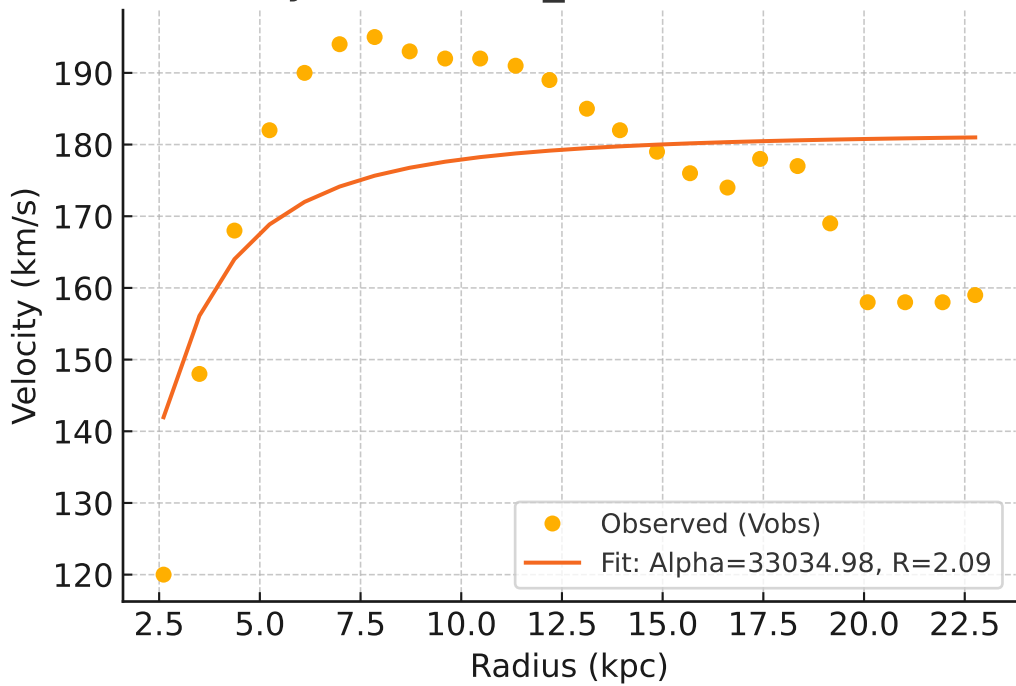




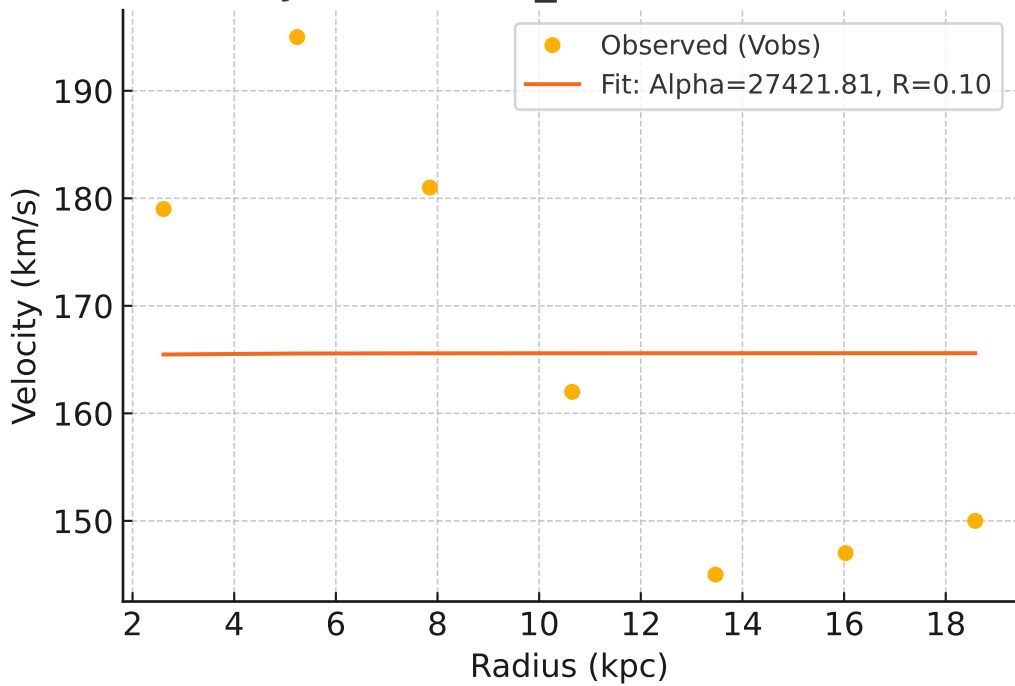
# Galaxy: NGC4088\_rotmod ( $R^2=0.911$ )



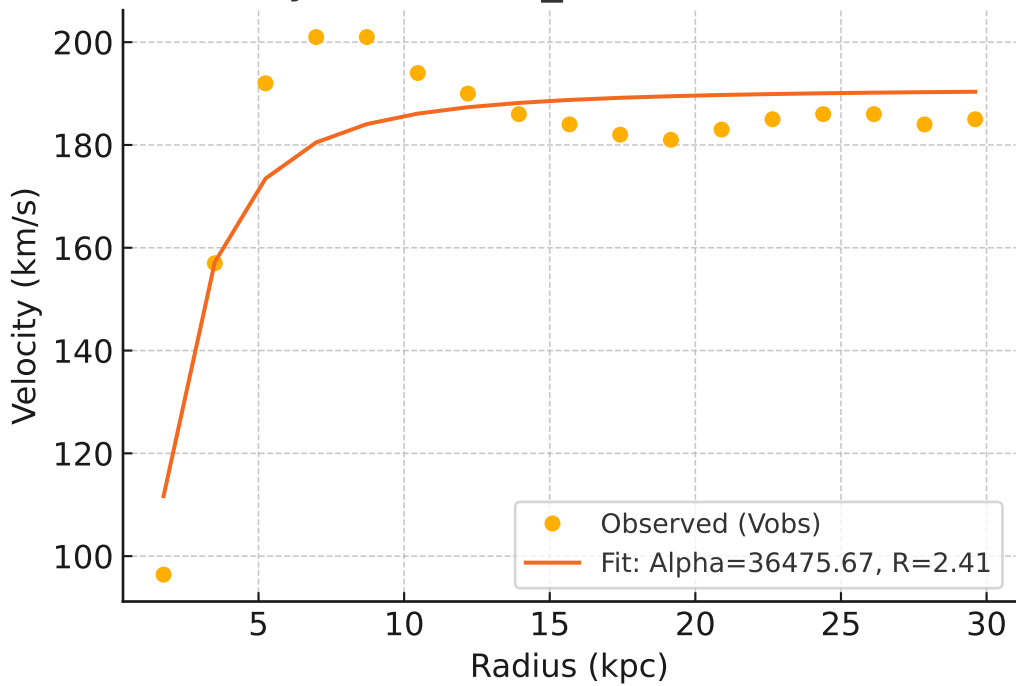
# Galaxy: NGC4100\_rotmod ( $R^2=0.331$ )



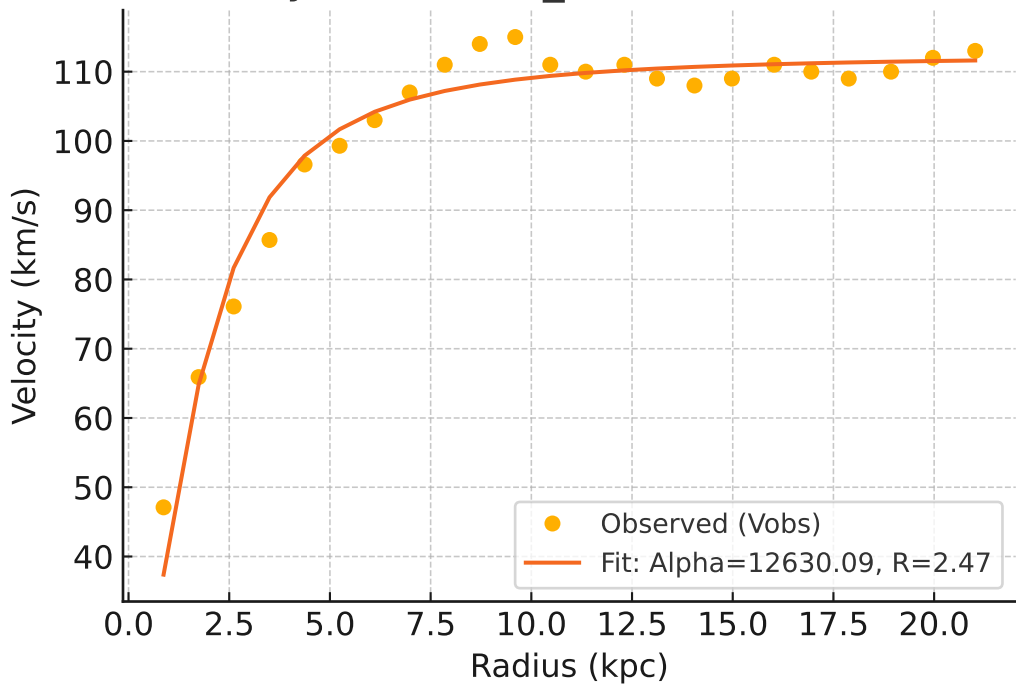
# Galaxy: NGC4138\_rotmod ( $R^2 = -0.002$ )



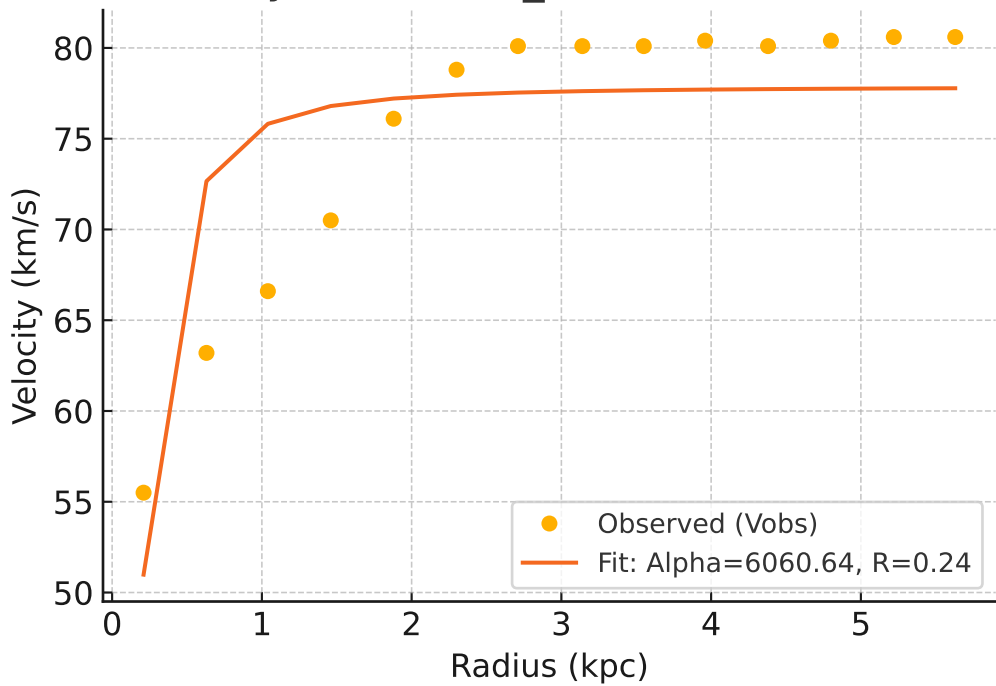
# Galaxy: NGC4157\_rotmod ( $R^2=0.814$ )



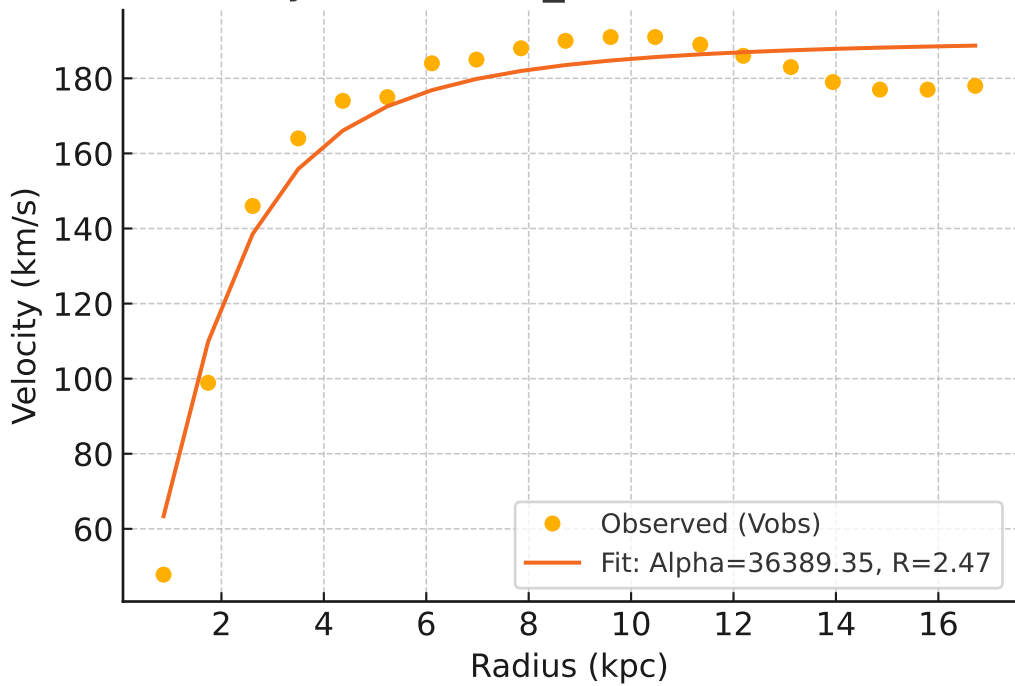
# Galaxy: NGC4183\_rotmod ( $R^2=0.956$ )



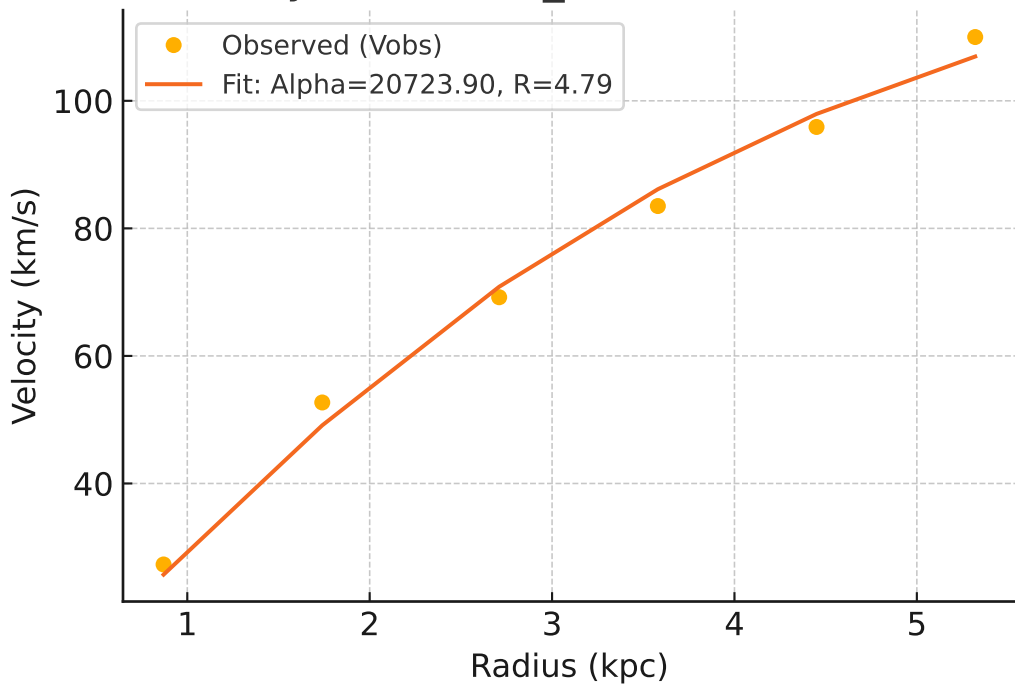
# Galaxy: NGC4214\_rotmod ( $R^2=0.656$ )



# Galaxy: NGC4217\_rotmod ( $R^2=0.947$ )

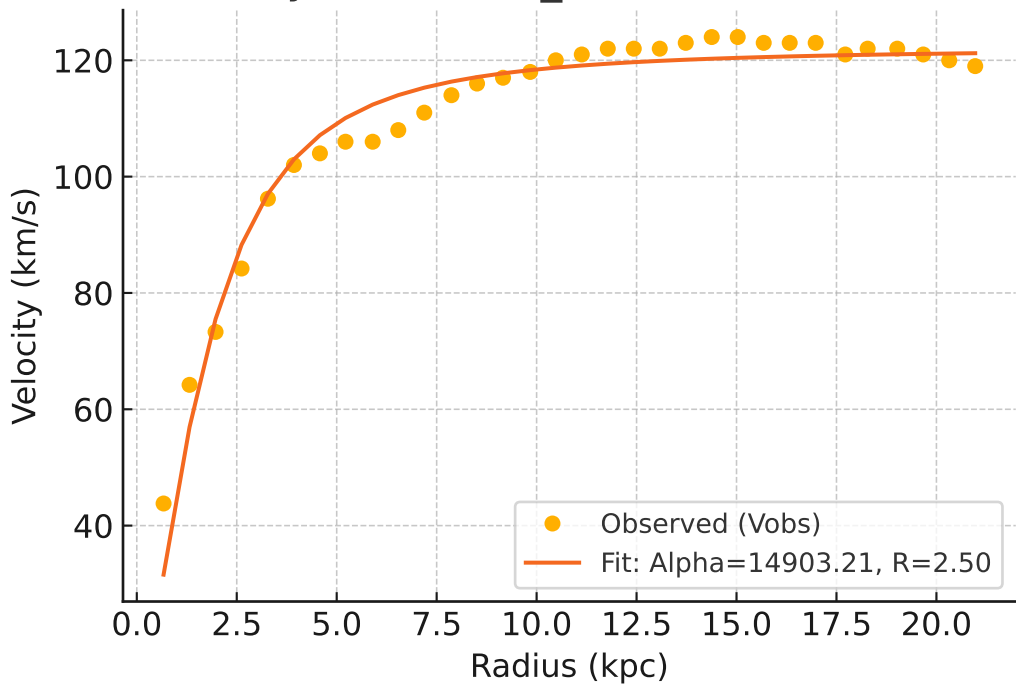


# Galaxy: NGC4389\_rotmod ( $R^2=0.991$ )

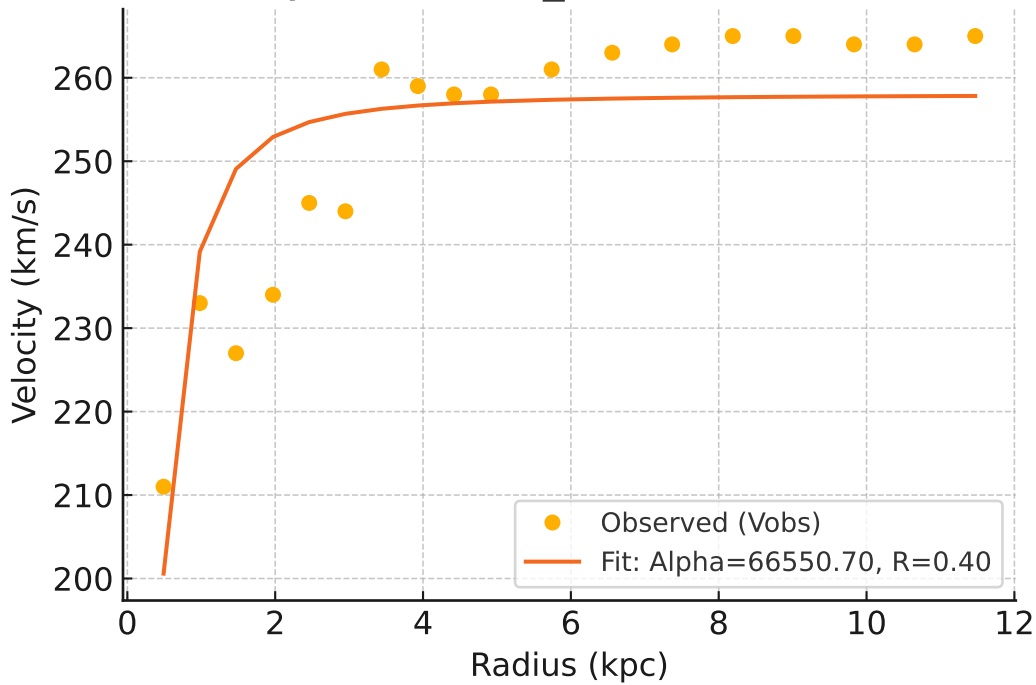




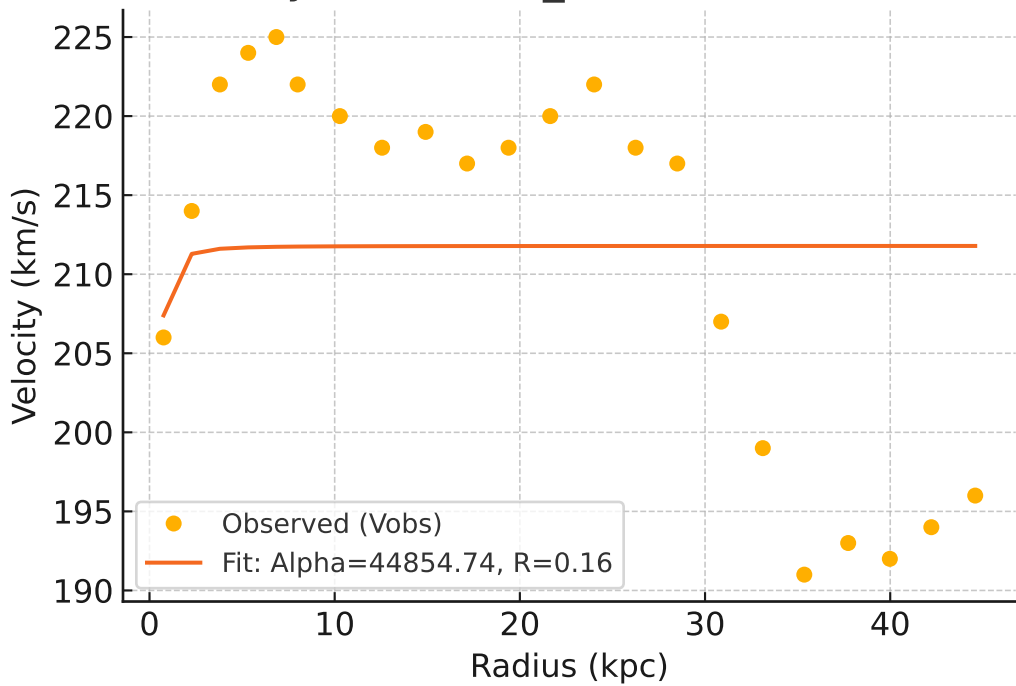
# Galaxy: NGC4559\_rotmod ( $R^2=0.962$ )



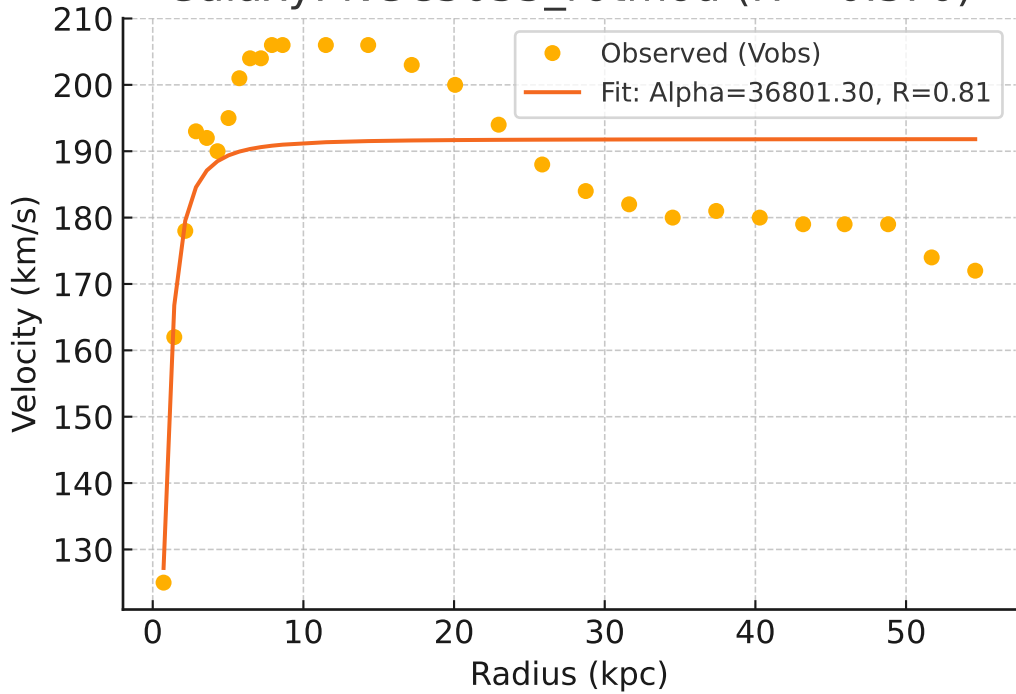
# Galaxy: NGC5005\_rotmod ( $R^2=0.647$ )



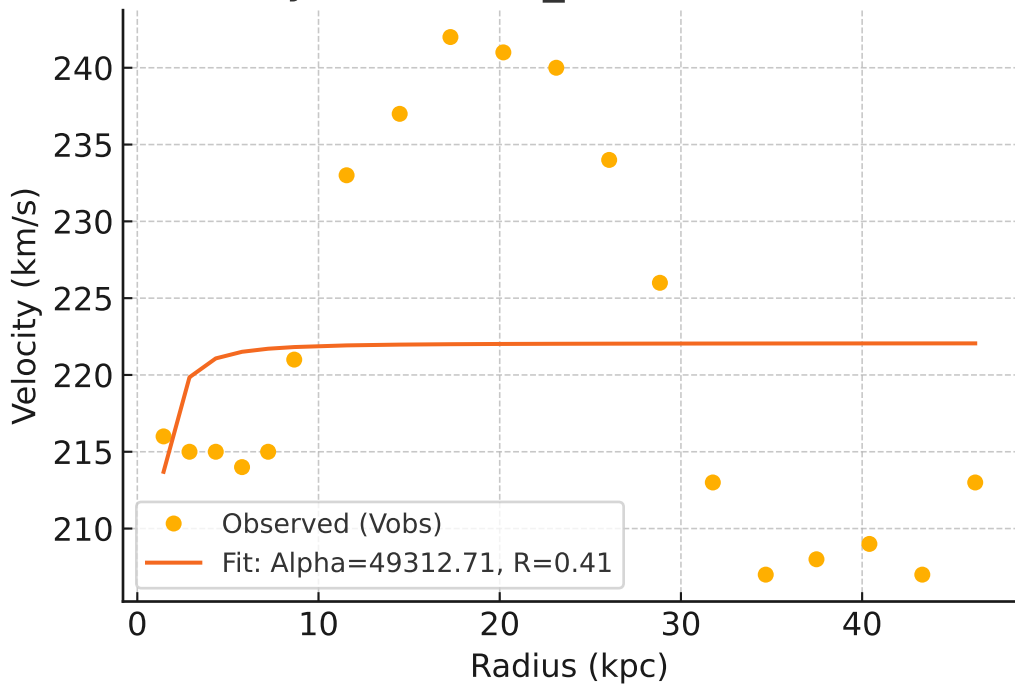
# Galaxy: NGC5033\_rotmod ( $R^2=0.006$ )



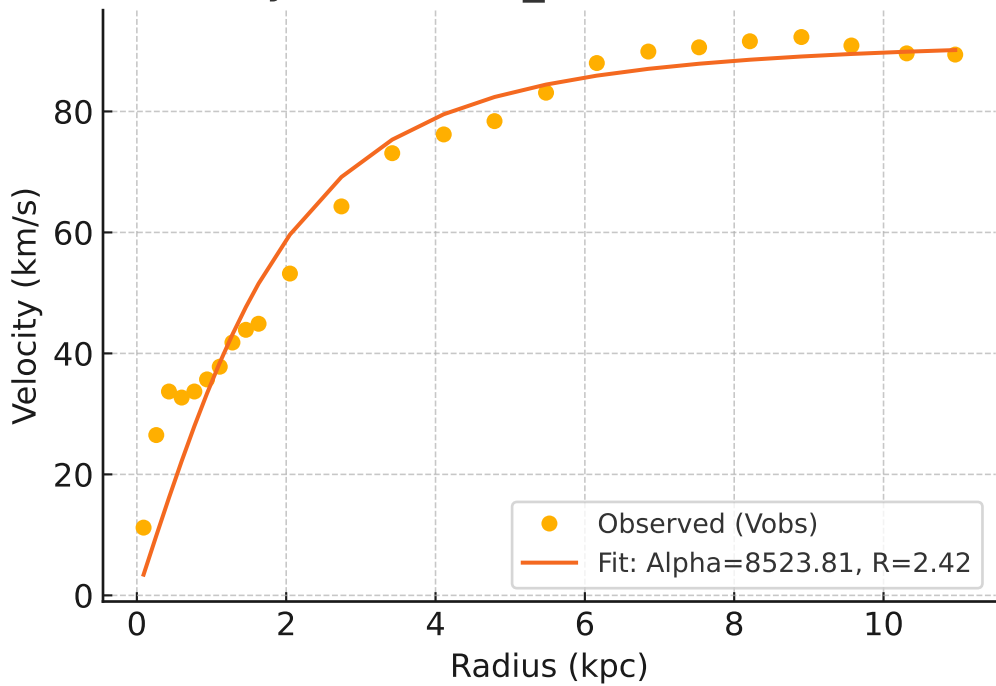
# Galaxy: NGC5055\_rotmod ( $R^2=0.570$ )



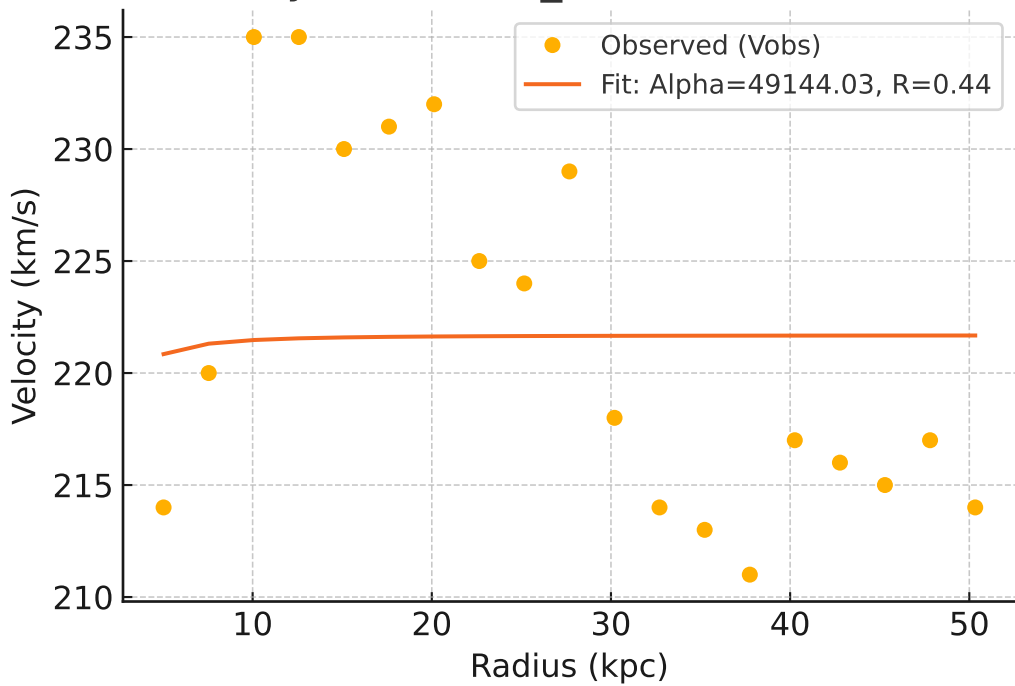
# Galaxy: NGC5371\_rotmod ( $R^2=0.023$ )



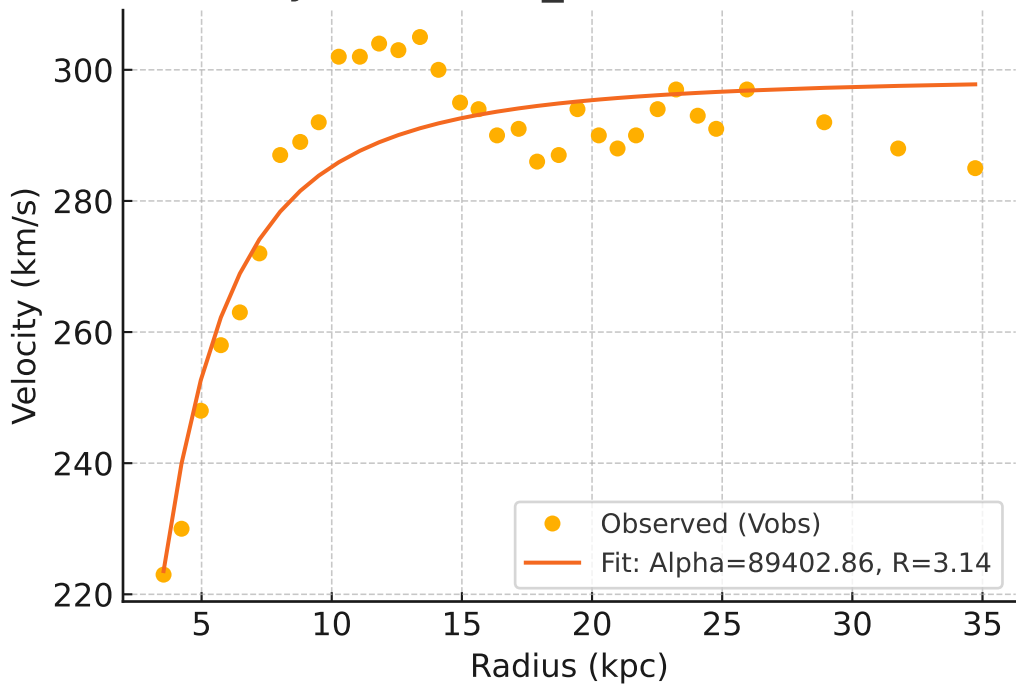
# Galaxy: NGC5585\_rotmod ( $R^2=0.938$ )



# Galaxy: NGC5907\_rotmod ( $R^2=0.001$ )

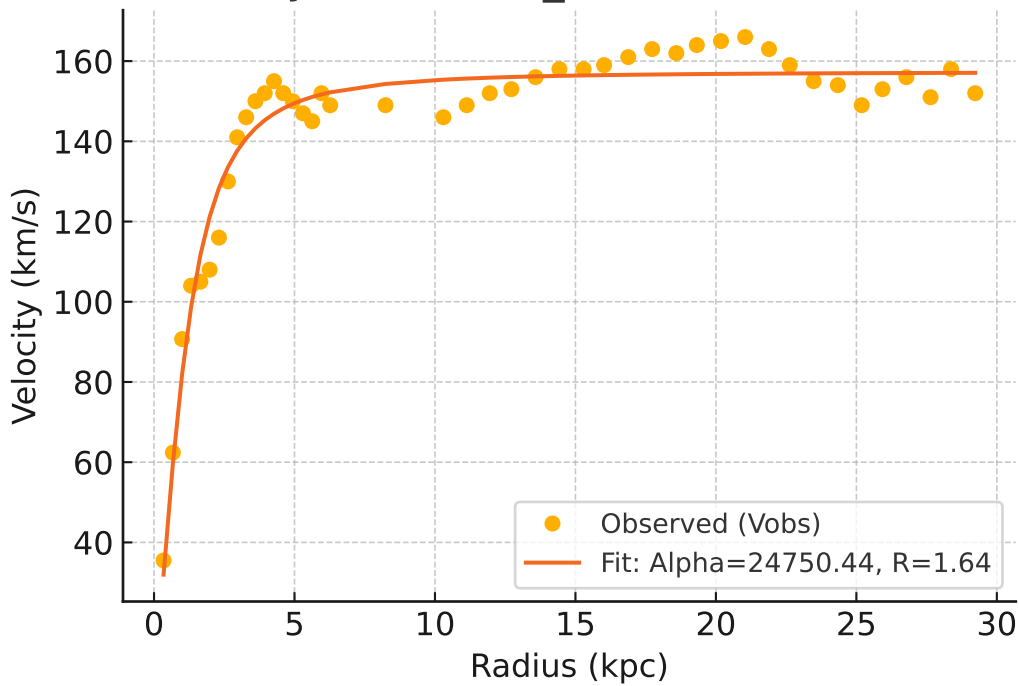


# Galaxy: NGC5985\_rotmod ( $R^2=0.831$ )

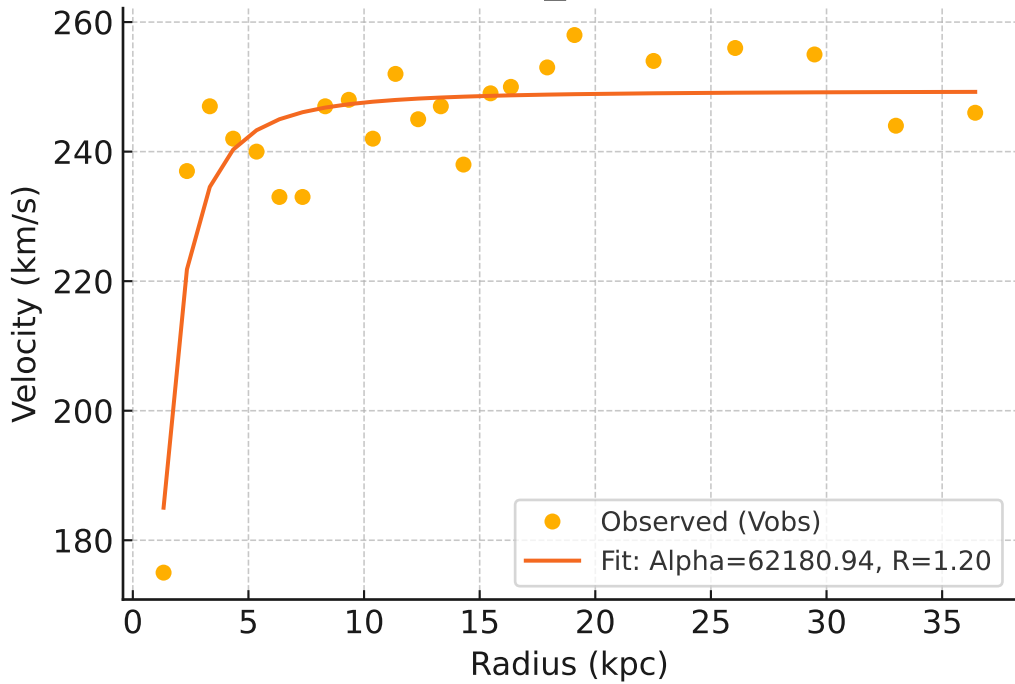




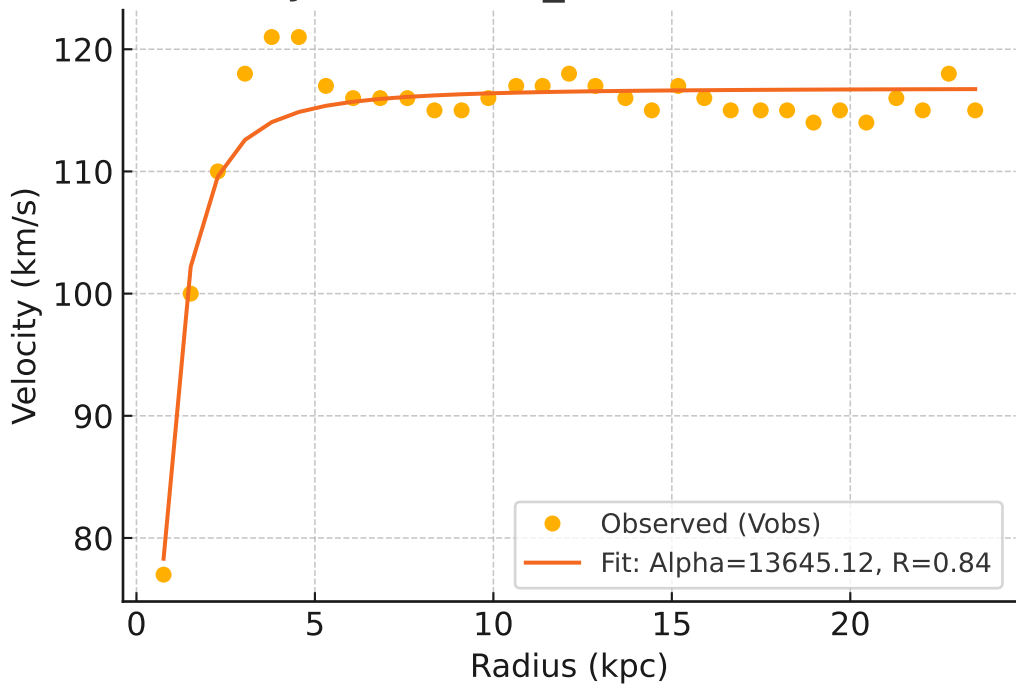
# Galaxy: NGC6015\_rotmod ( $R^2=0.954$ )



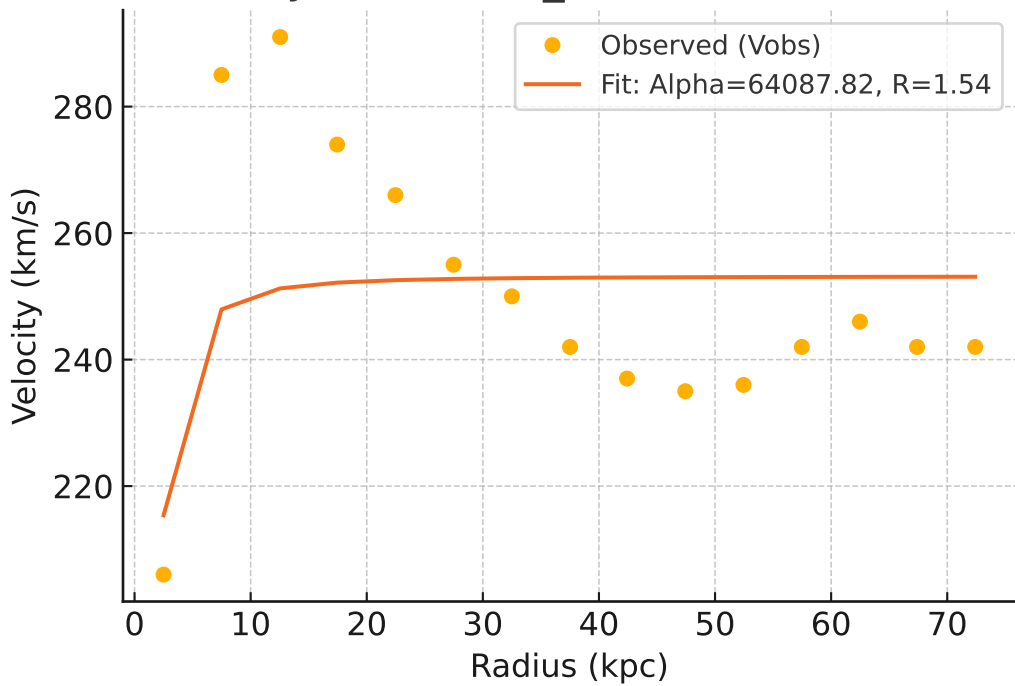
# Galaxy: NGC6195\_rotmod ( $R^2=0.791$ )



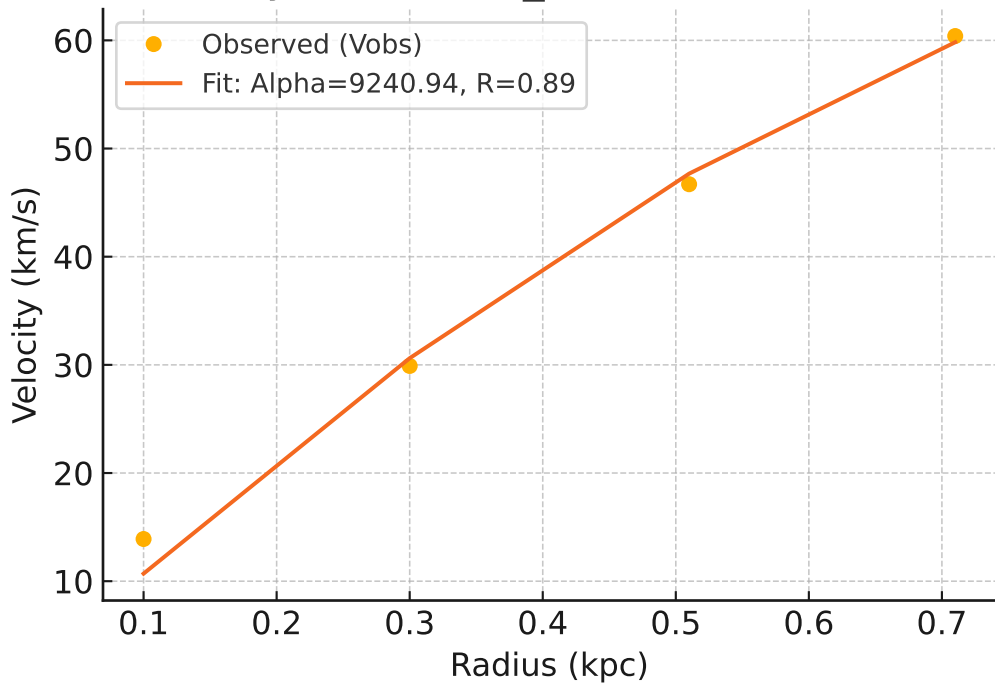
# Galaxy: NGC6503\_rotmod ( $R^2=0.907$ )



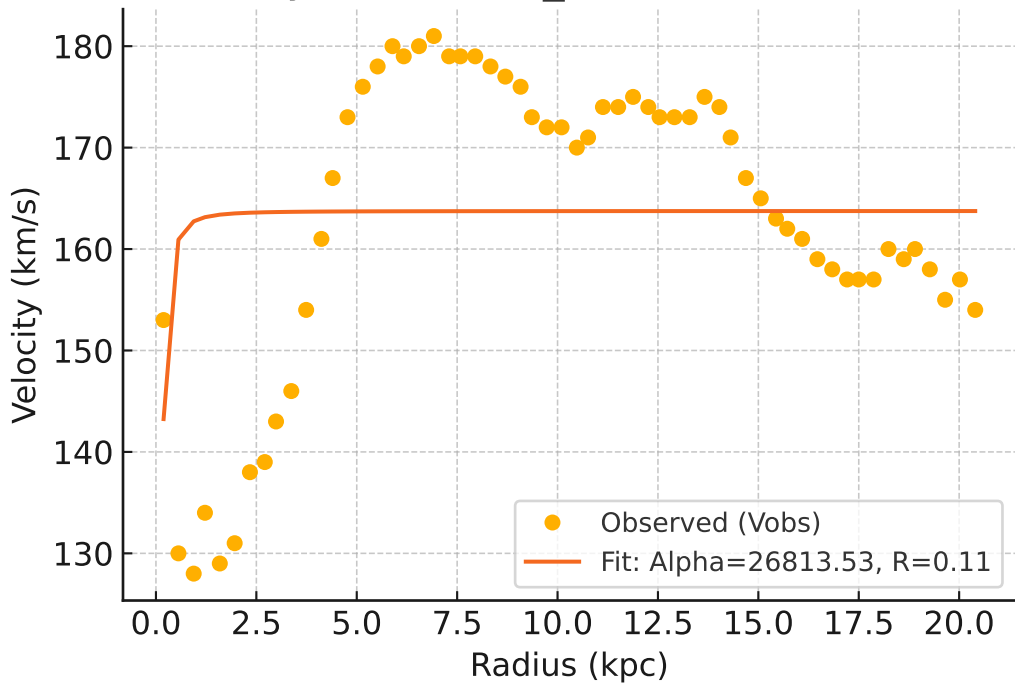
# Galaxy: NGC6674\_rotmod ( $R^2=0.220$ )



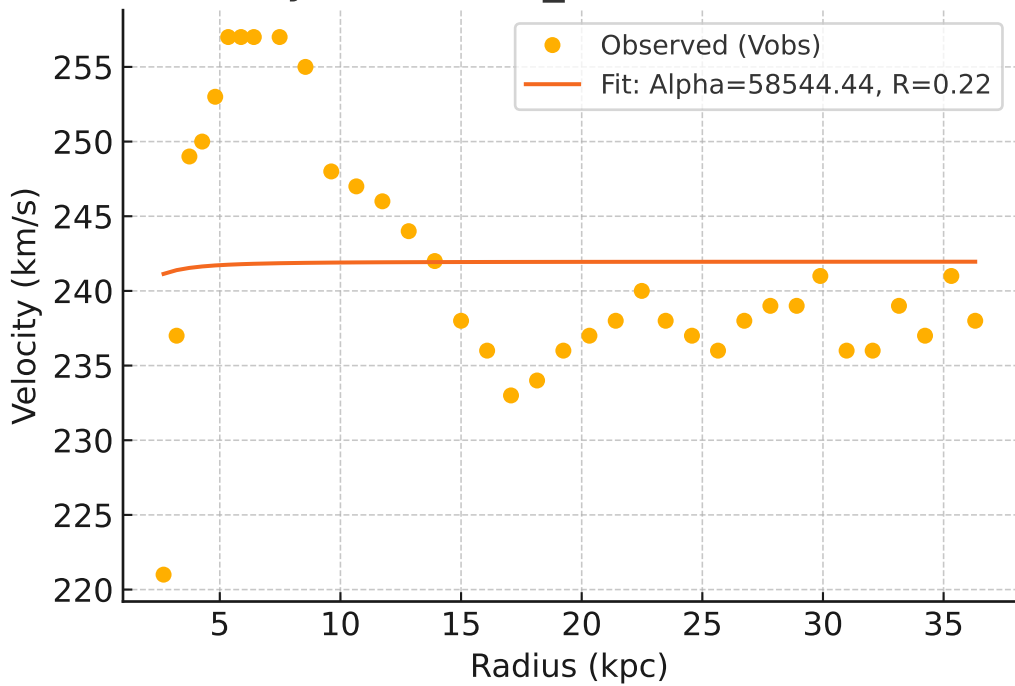
# Galaxy: NGC6789\_rotmod ( $R^2=0.990$ )



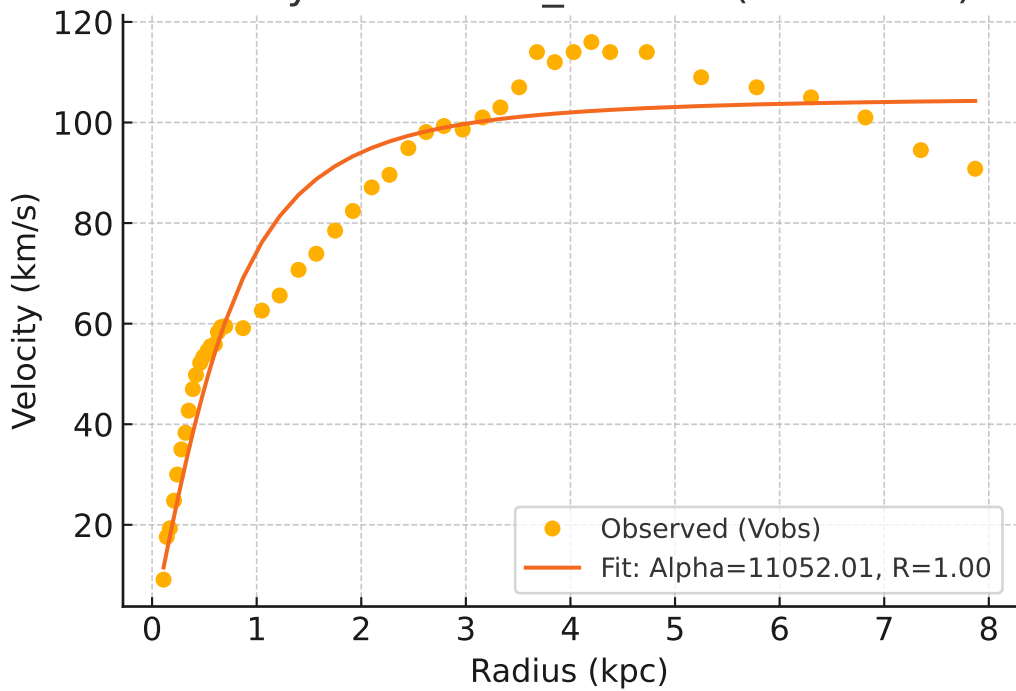
# Galaxy: NGC6946\_rotmod ( $R^2=0.028$ )



# Galaxy: NGC7331\_rotmod ( $R^2=0.001$ )

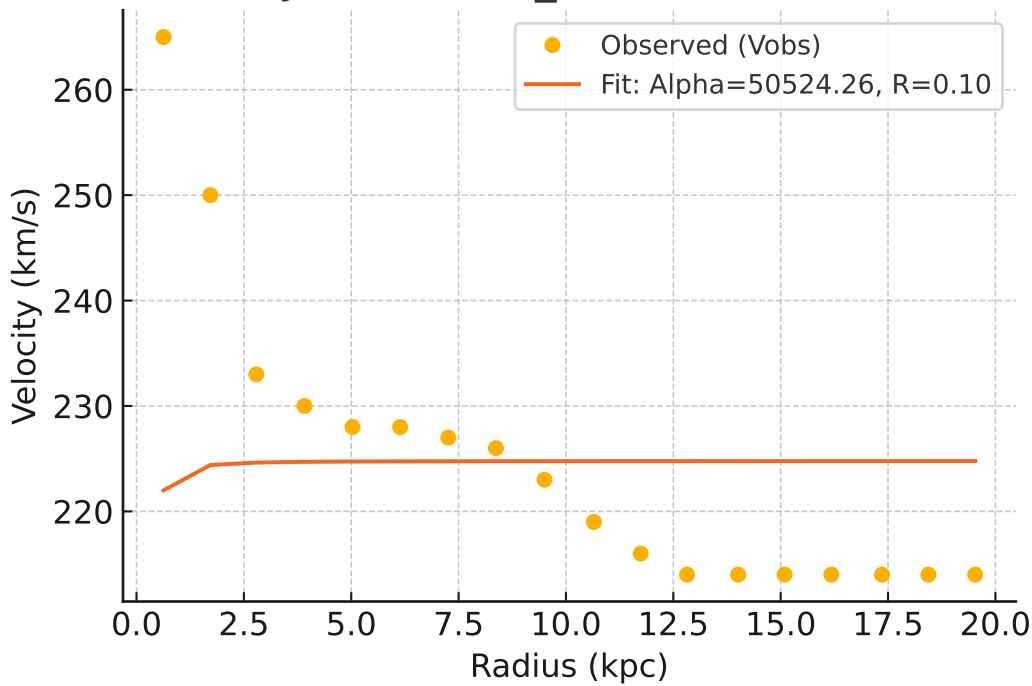


# Galaxy: NGC7793\_rotmod ( $R^2=0.927$ )

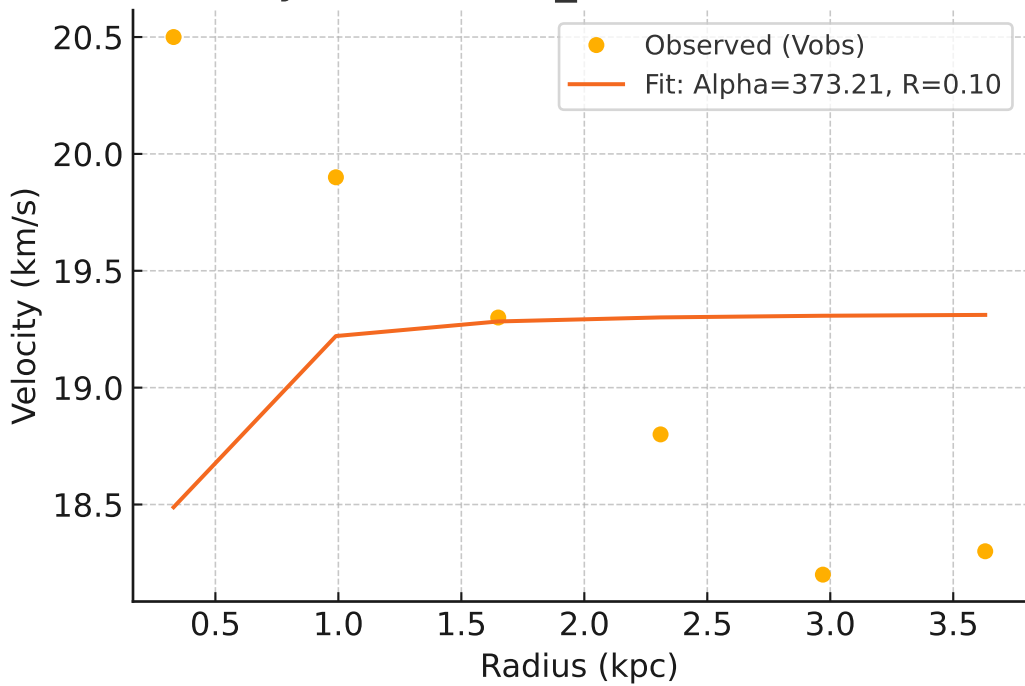




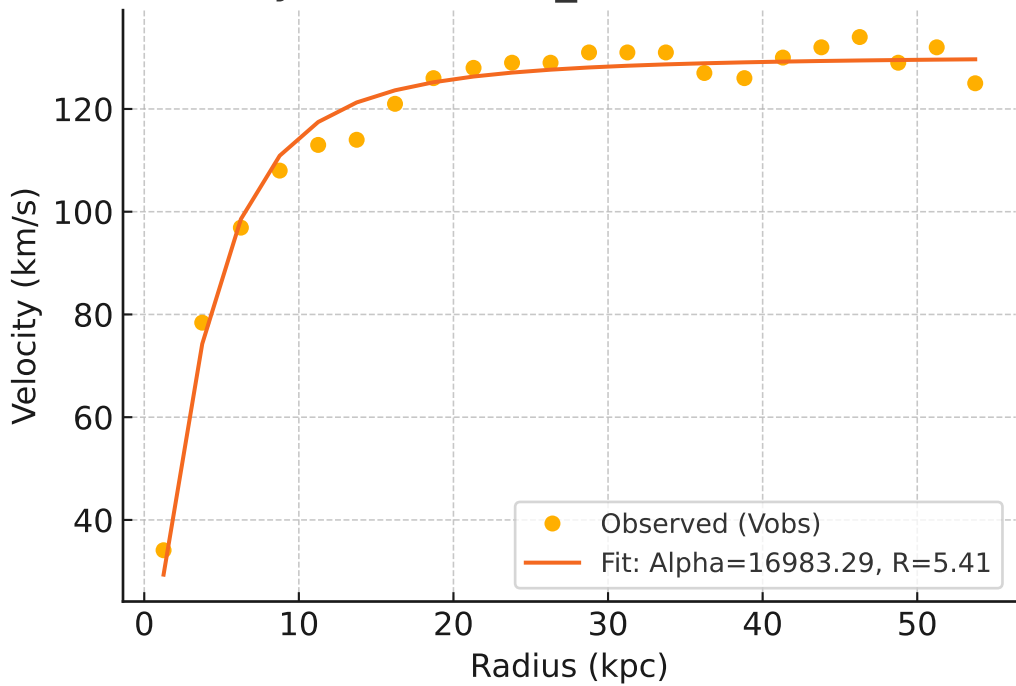
# Galaxy: NGC7814\_rotmod ( $R^2=-0.077$ )



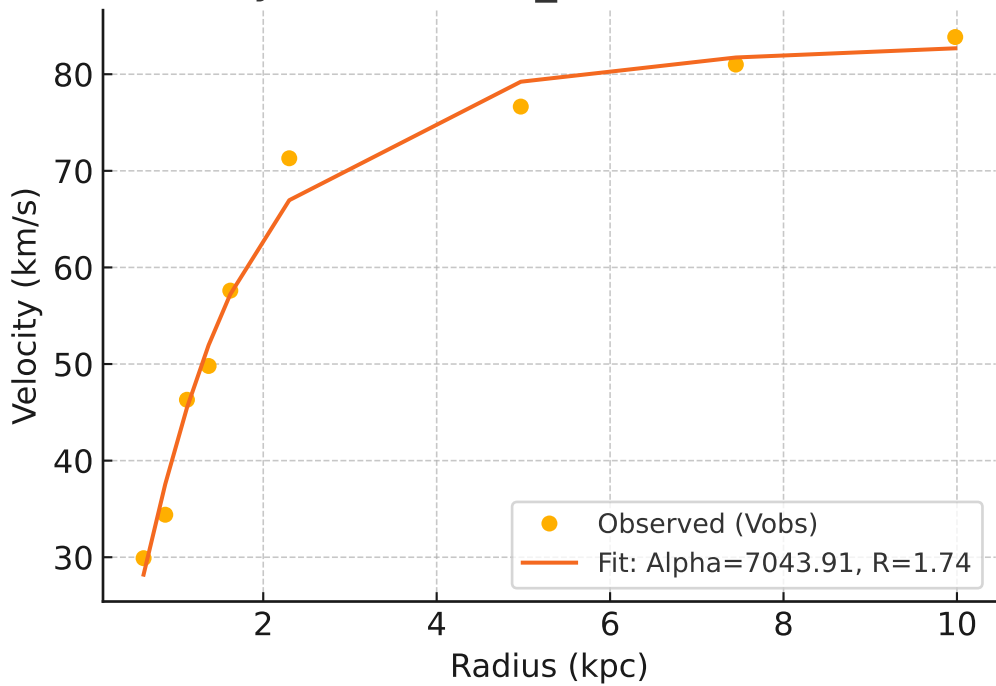
# Galaxy: PGC51017\_rotmod ( $R^2 = -0.687$ )



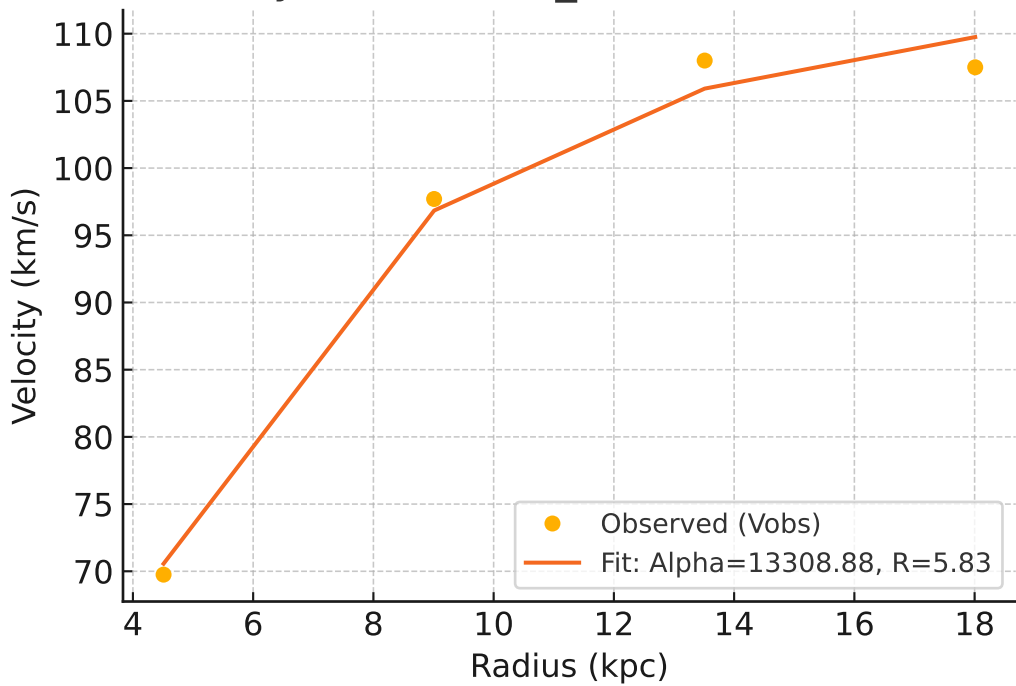
# Galaxy: UGC00128\_rotmod ( $R^2=0.980$ )



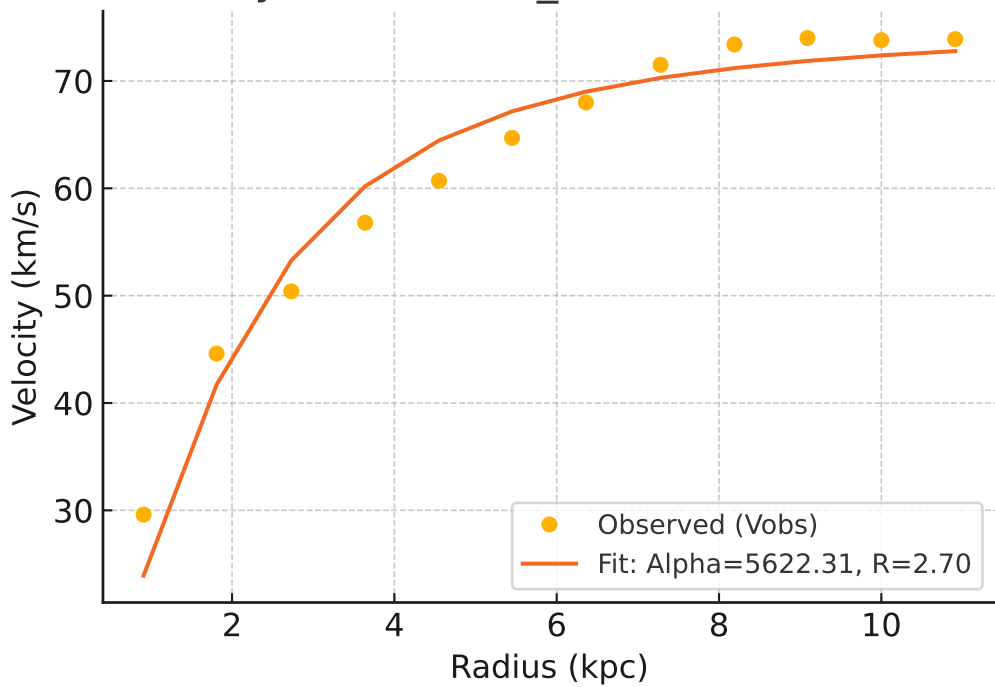
# Galaxy: UGC00191\_rotmod ( $R^2=0.986$ )



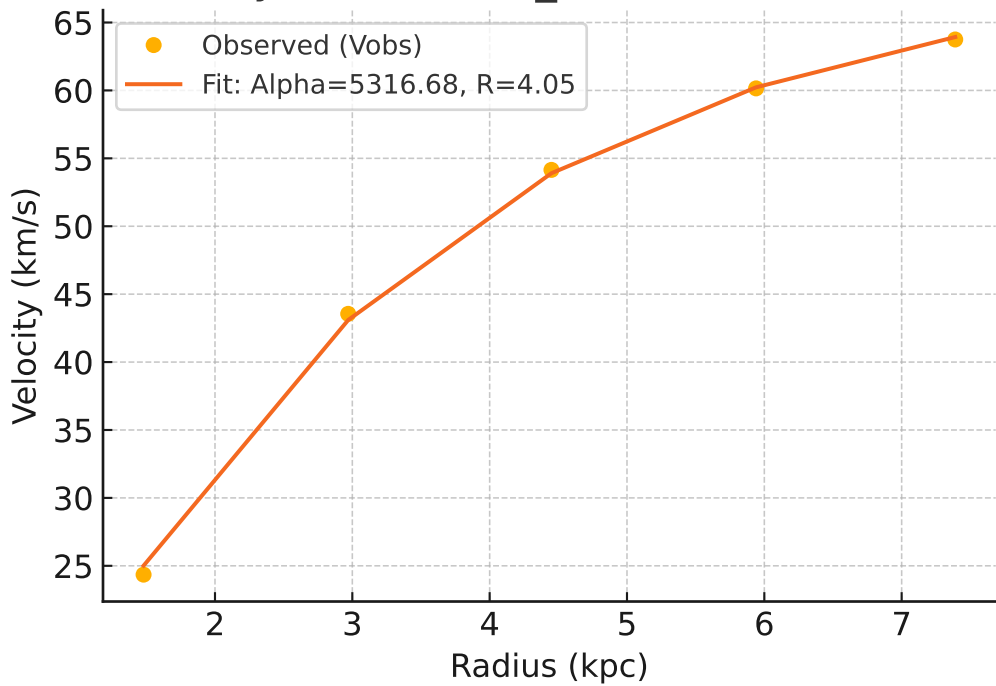
# Galaxy: UGC00634\_rotmod ( $R^2=0.989$ )



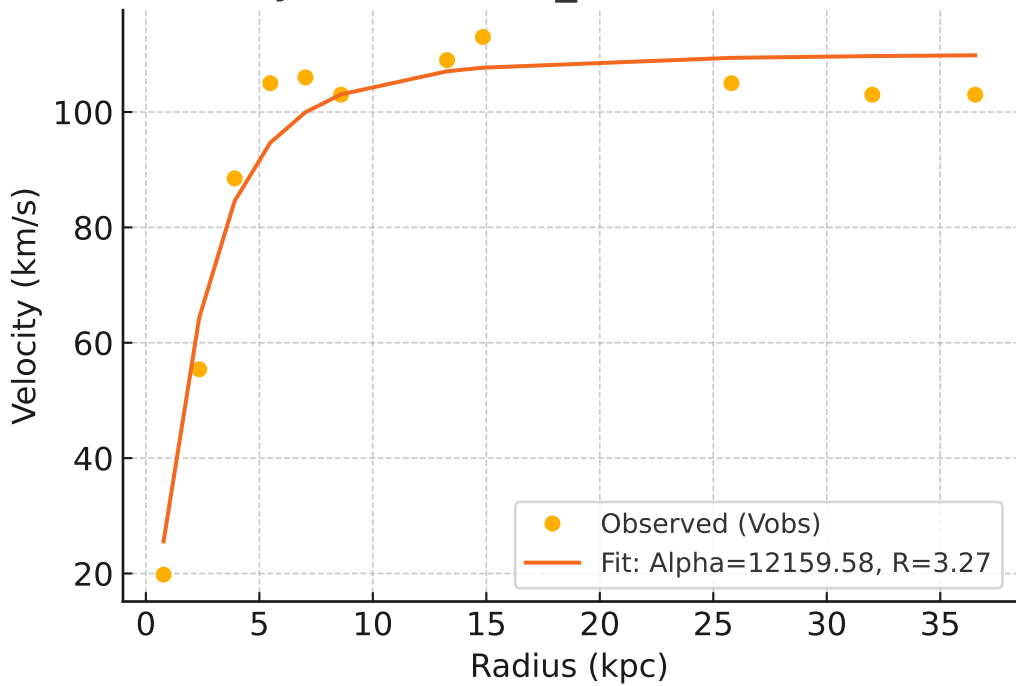
# Galaxy: UGC00731\_rotmod ( $R^2=0.957$ )



# Galaxy: UGC00891\_rotmod ( $R^2=0.999$ )

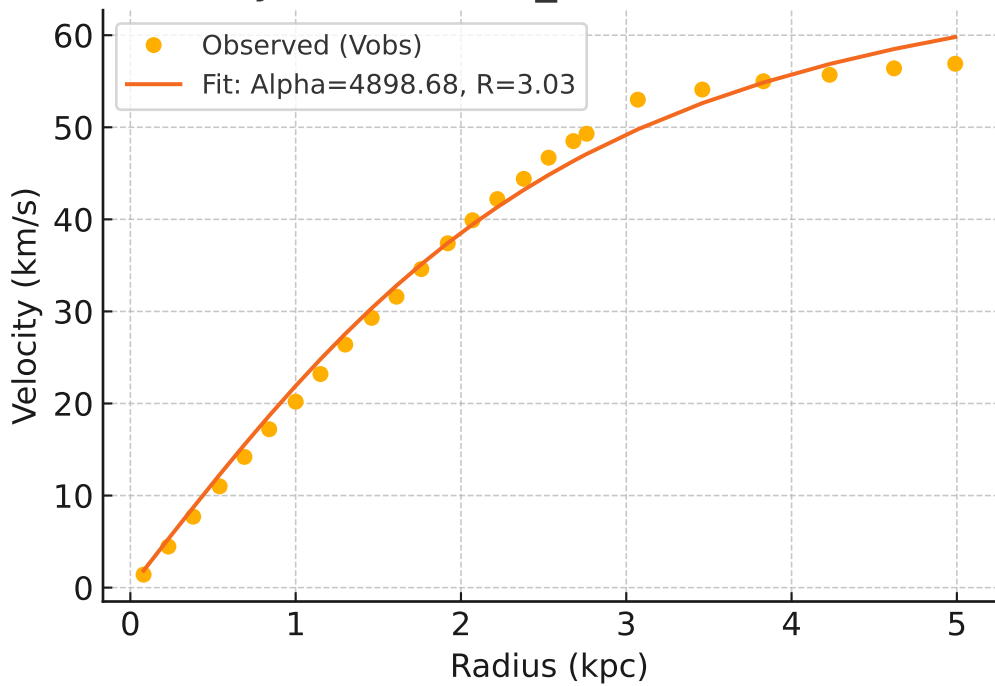


# Galaxy: UGC01230\_rotmod ( $R^2=0.949$ )

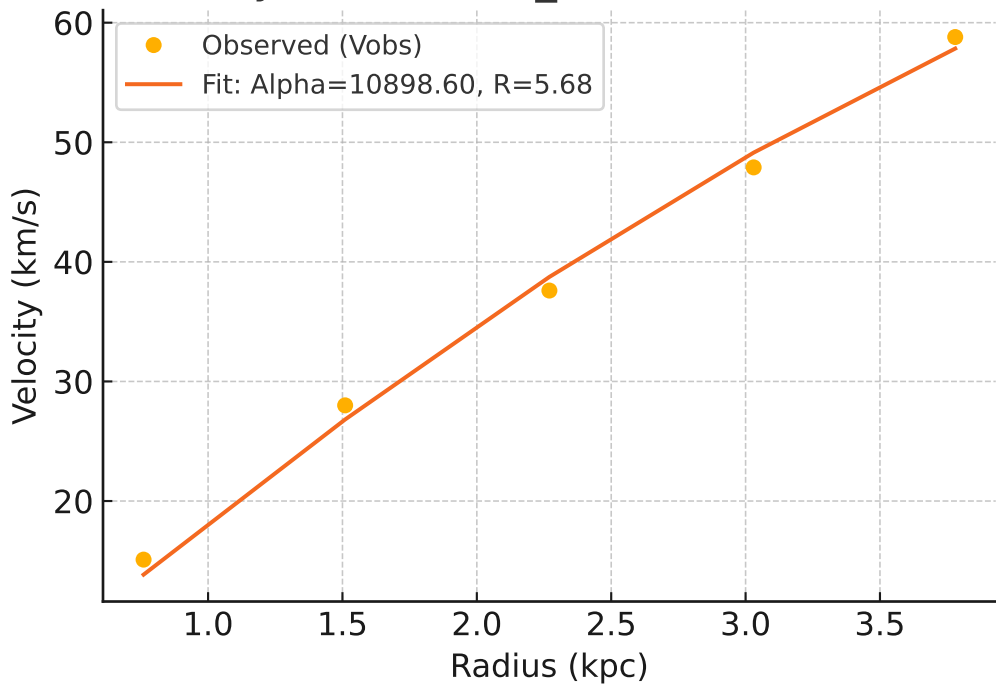




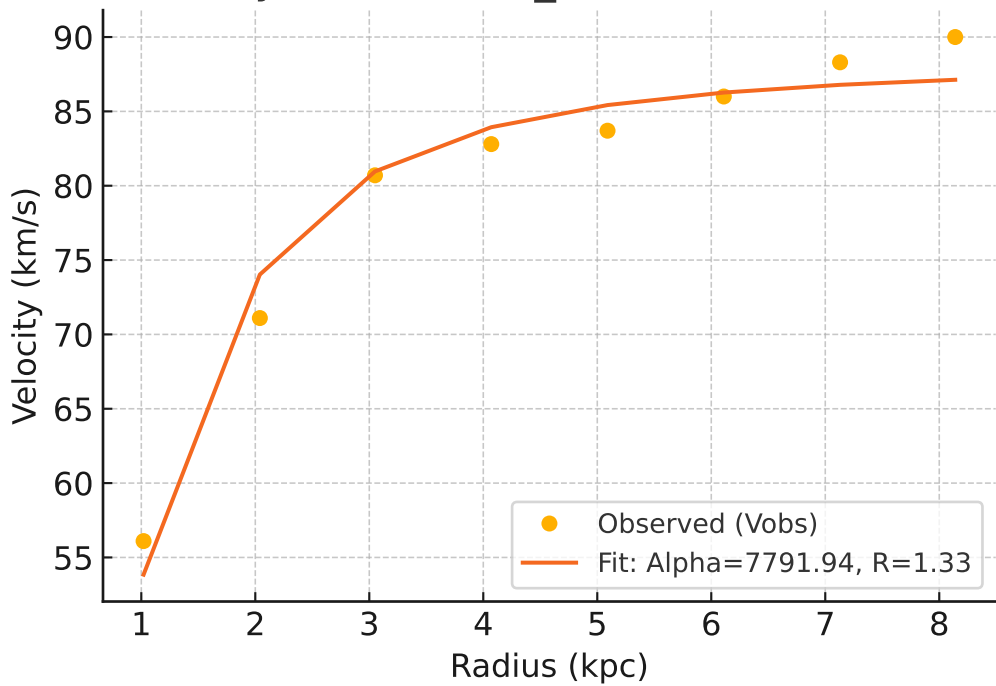
# Galaxy: UGC01281\_rotmod ( $R^2=0.992$ )



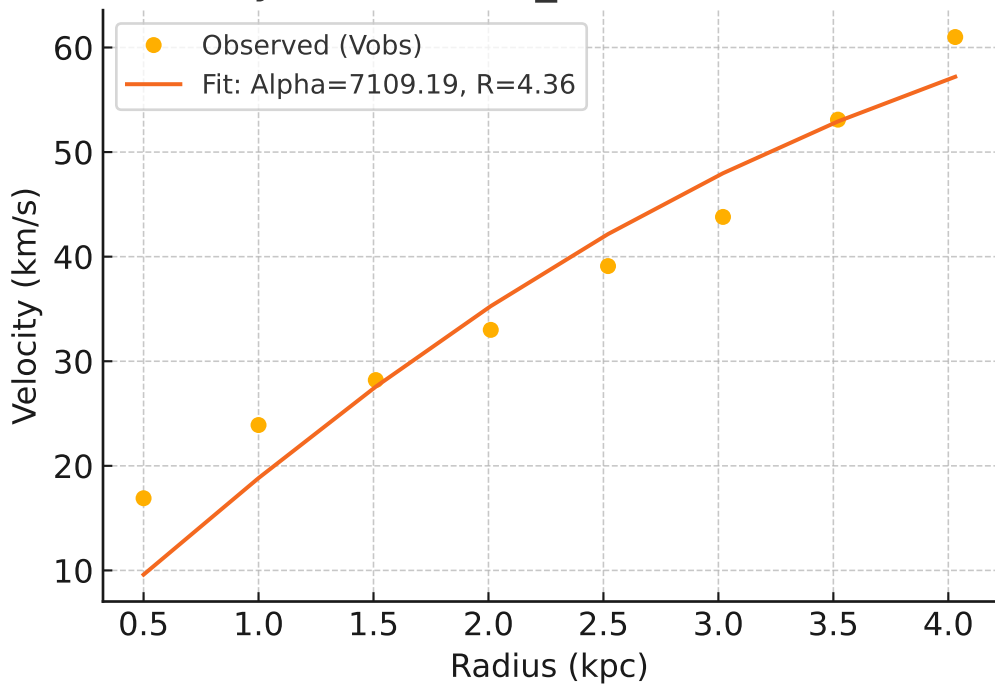
# Galaxy: UGC02023\_rotmod ( $R^2=0.994$ )



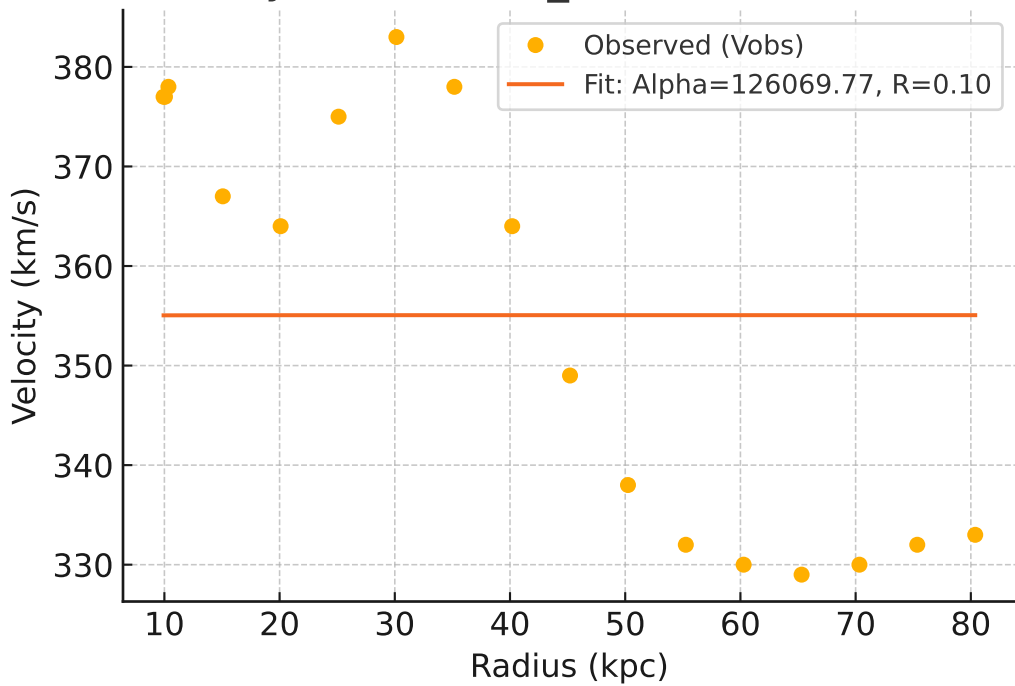
# Galaxy: UGC02259\_rotmod ( $R^2=0.967$ )



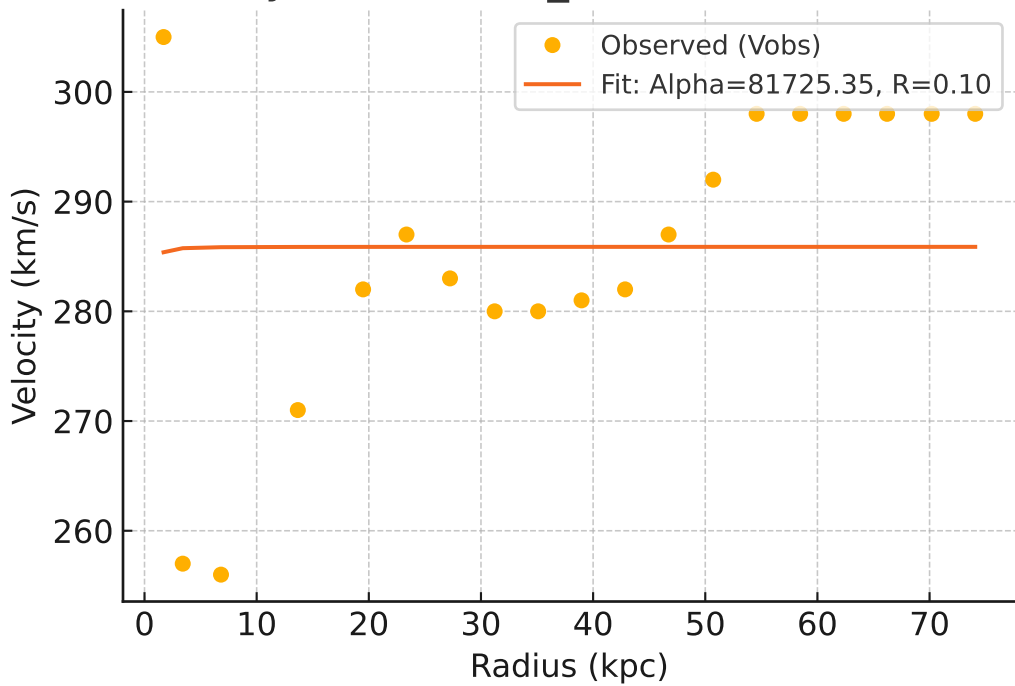
# Galaxy: UGC02455\_rotmod ( $R^2=0.919$ )



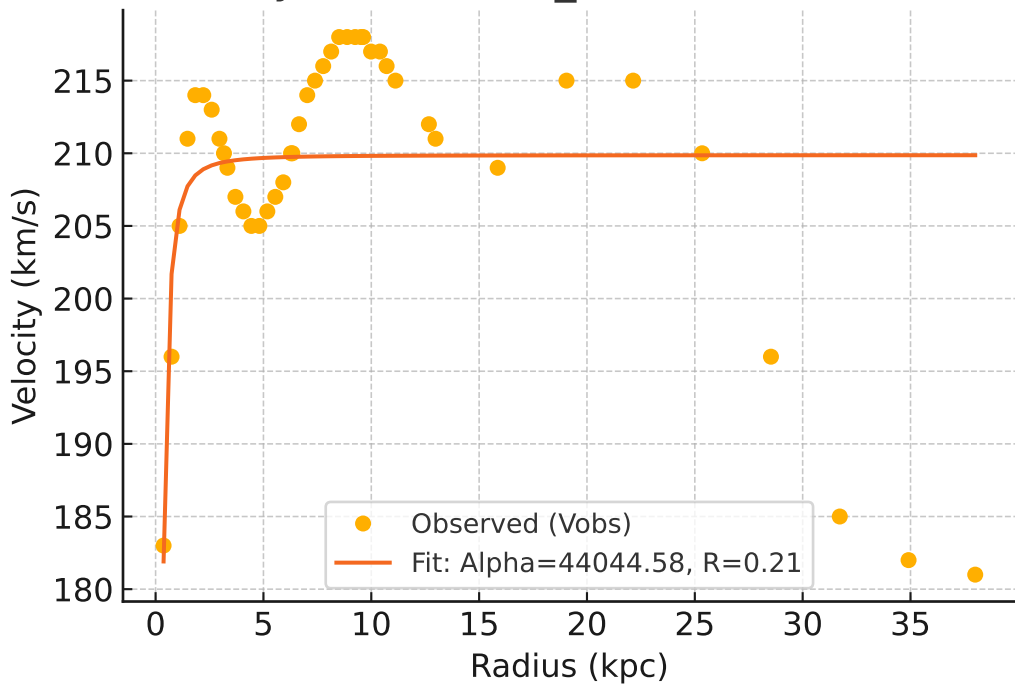
# Galaxy: UGC02487\_rotmod ( $R^2=-0.000$ )



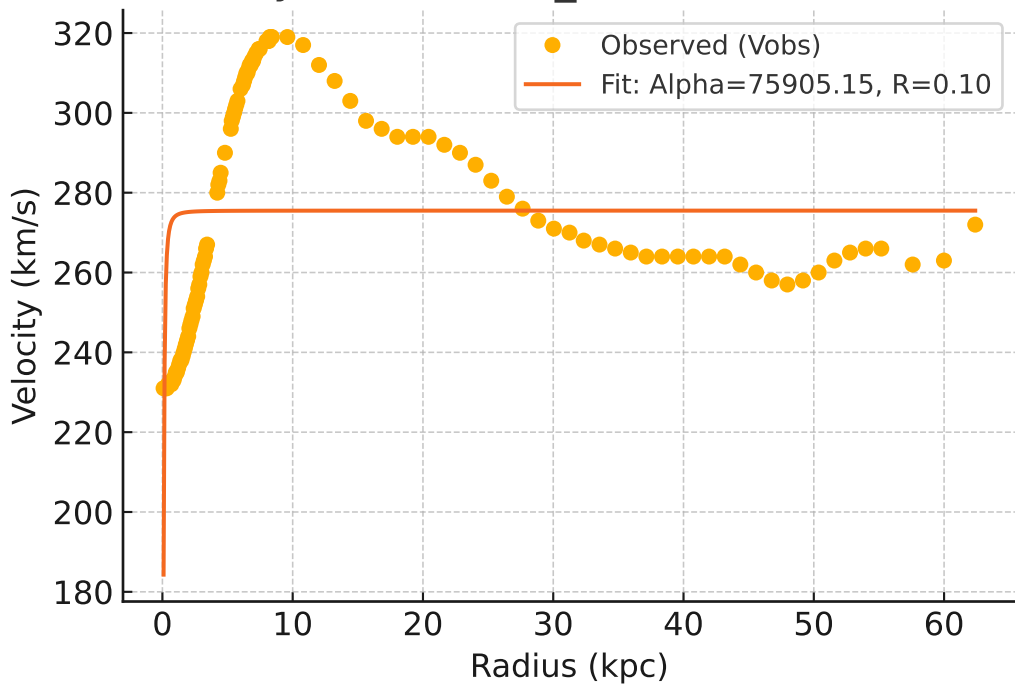
# Galaxy: UGC02885\_rotmod ( $R^2=-0.003$ )



# Galaxy: UGC02916\_rotmod ( $R^2=0.195$ )

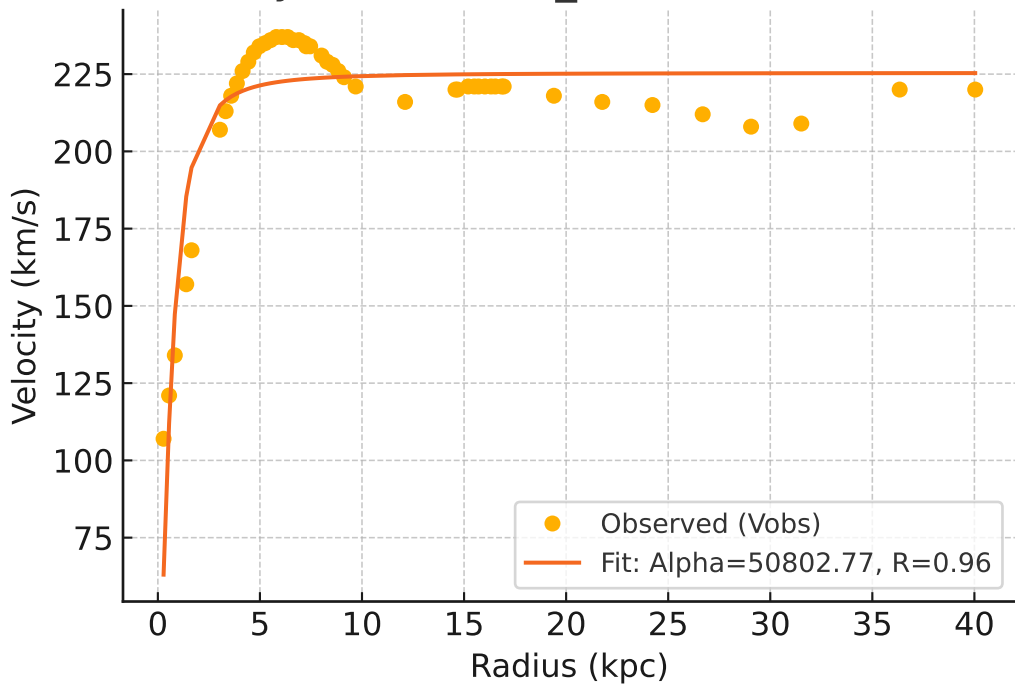


# Galaxy: UGC02953\_rotmod ( $R^2=0.068$ )

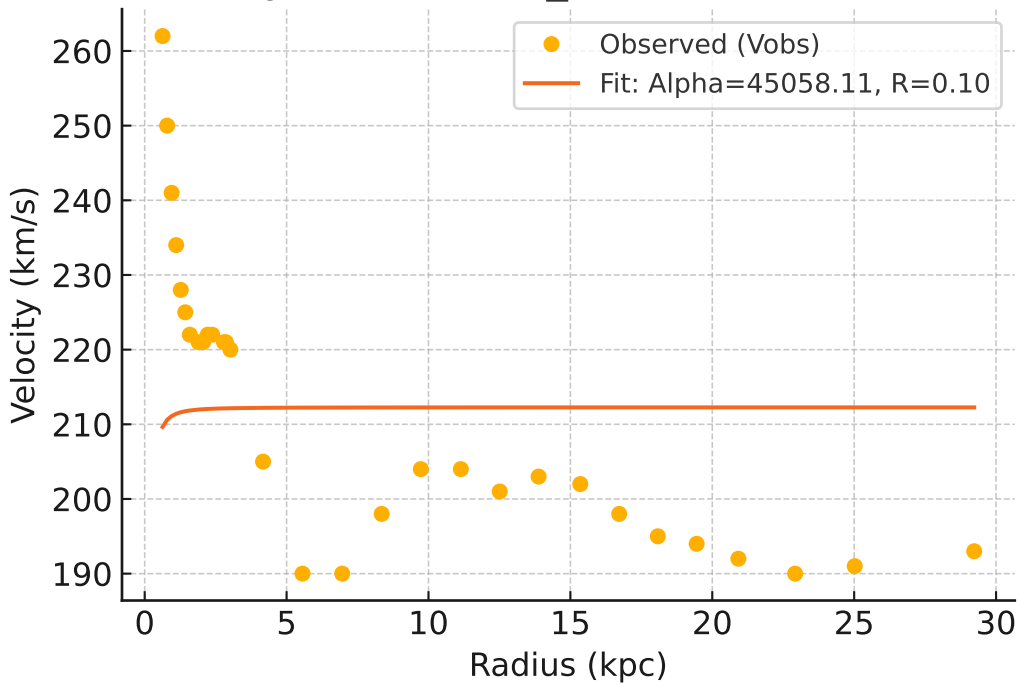




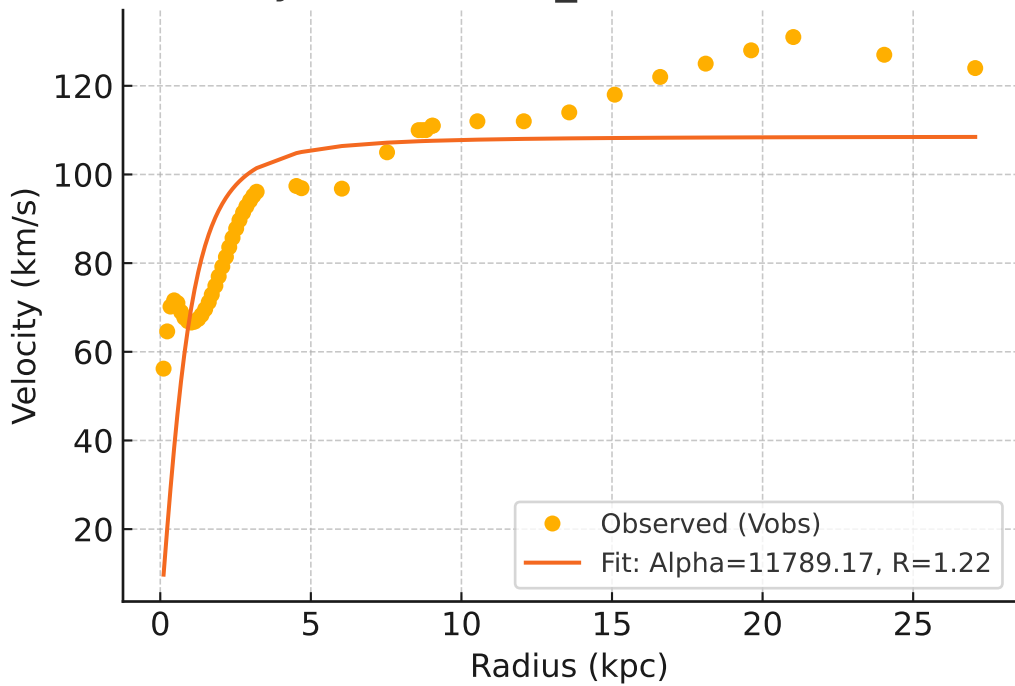
# Galaxy: UGC03205\_rotmod ( $R^2=0.815$ )



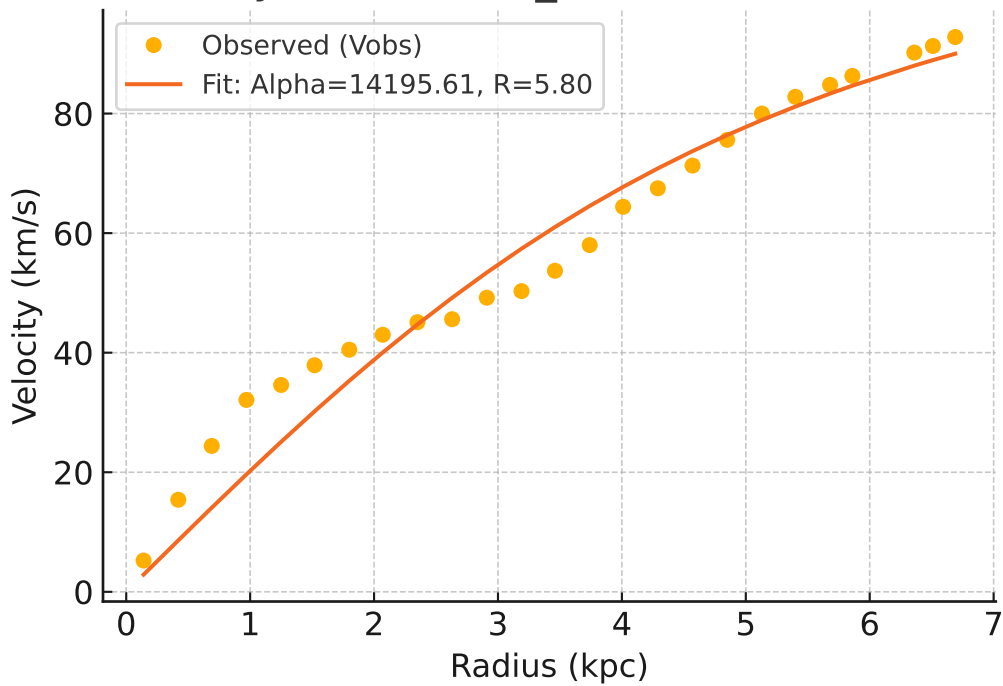
# Galaxy: UGC03546\_rotmod ( $R^2 = -0.054$ )



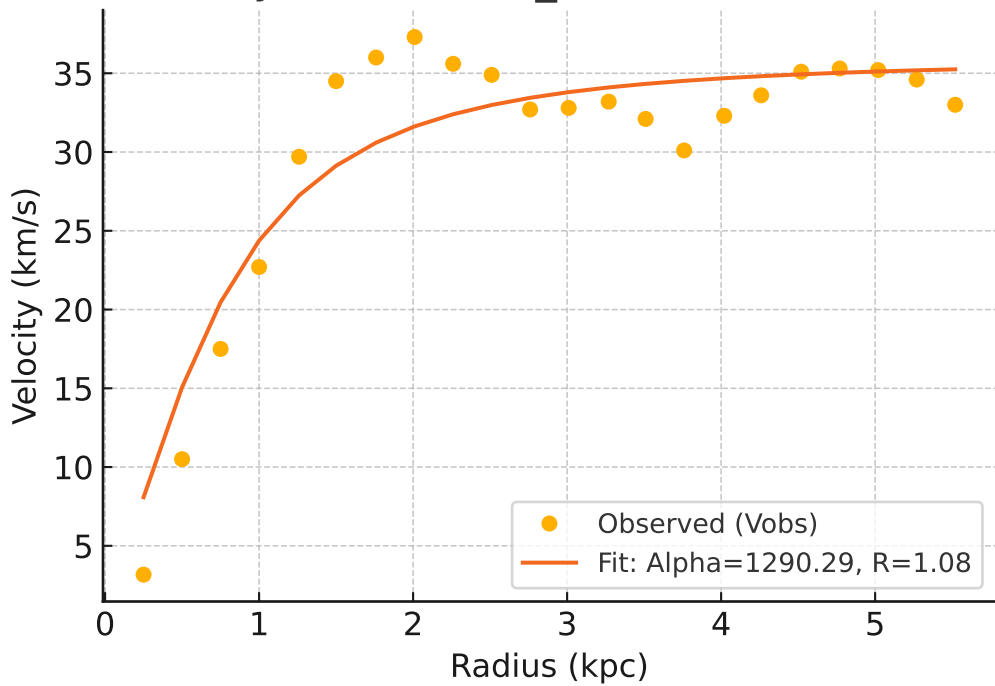
# Galaxy: UGC03580\_rotmod ( $R^2=0.385$ )



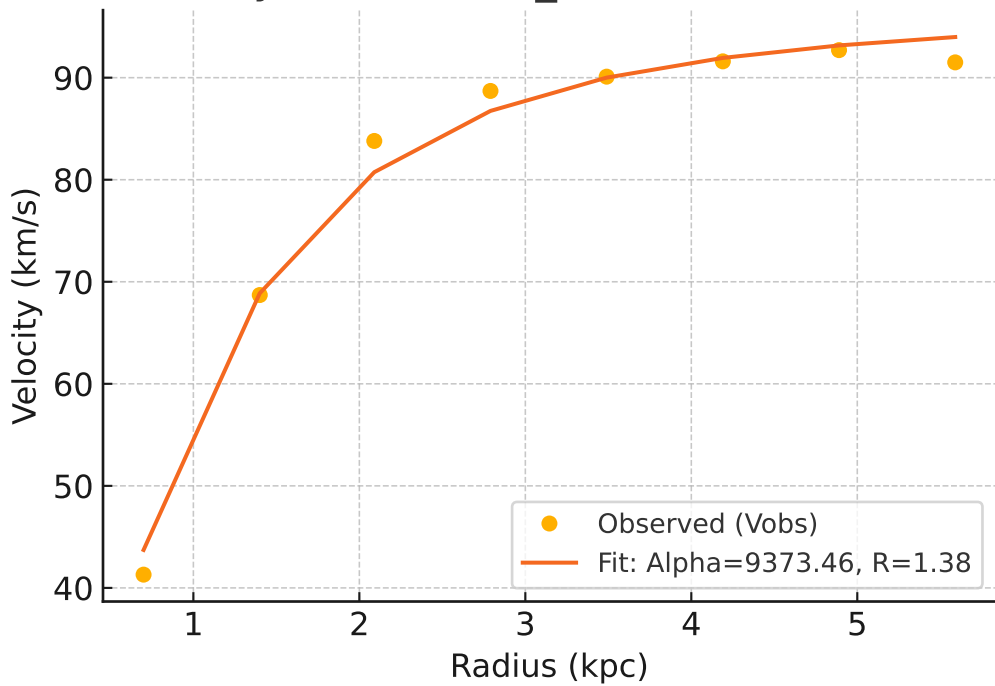
# Galaxy: UGC04278\_rotmod ( $R^2=0.951$ )



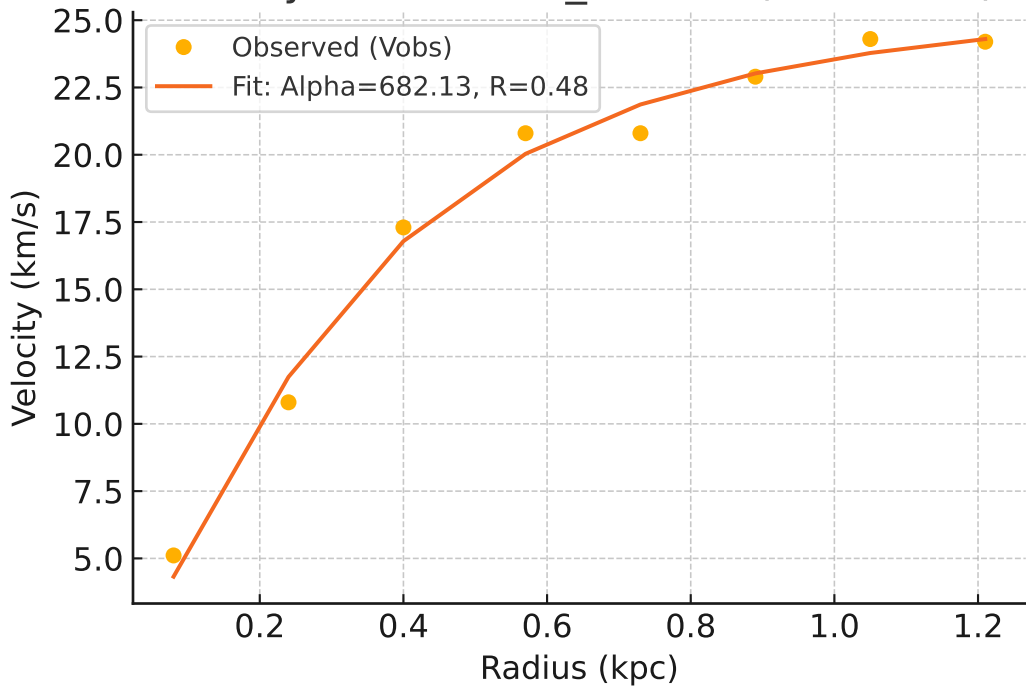
# Galaxy: UGC04305\_rotmod ( $R^2=0.874$ )



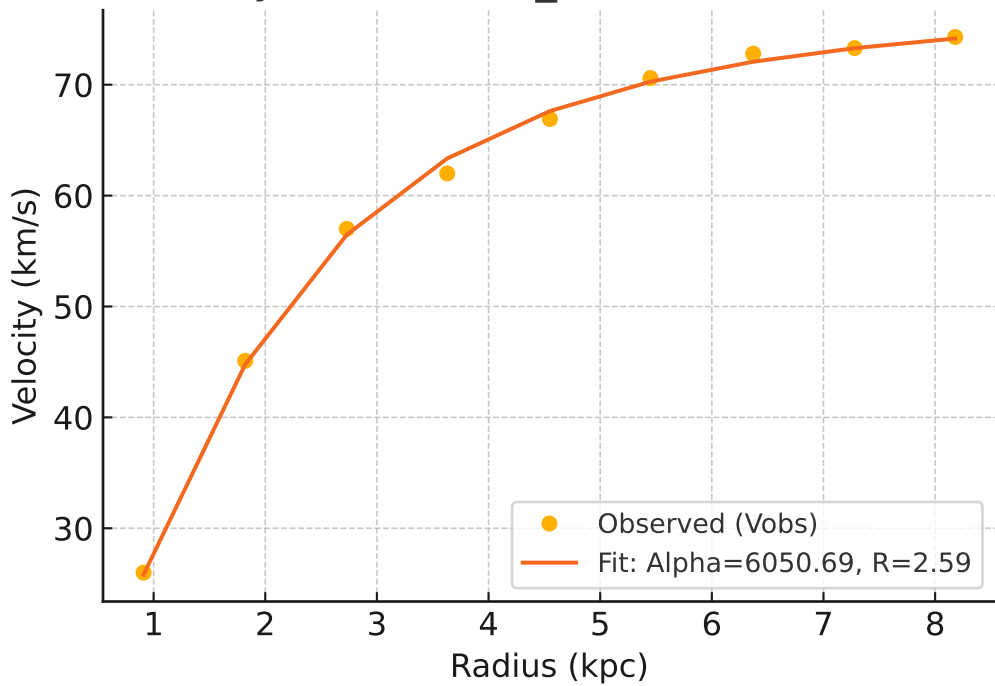
# Galaxy: UGC04325\_rotmod ( $R^2=0.989$ )



# Galaxy: UGC04483\_rotmod ( $R^2=0.989$ )

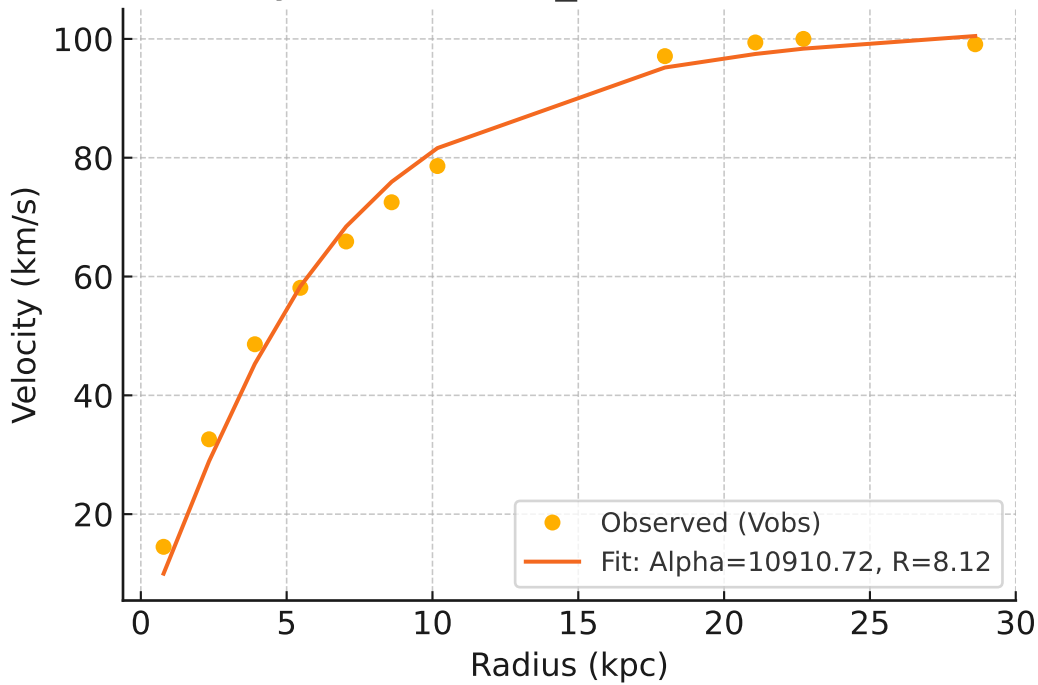


# Galaxy: UGC04499\_rotmod ( $R^2=0.998$ )

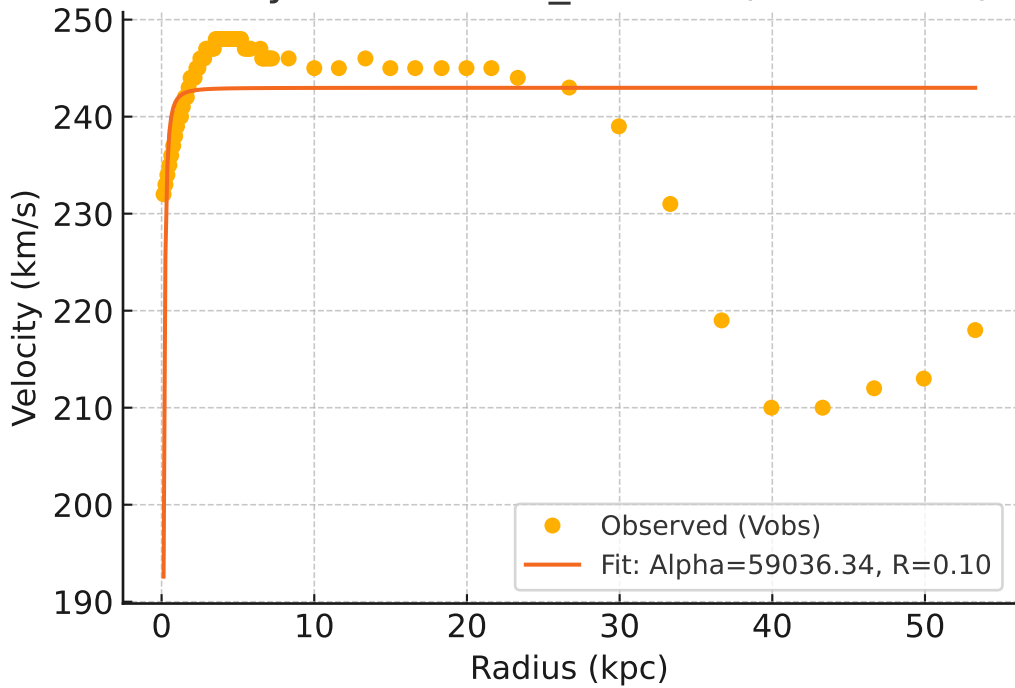




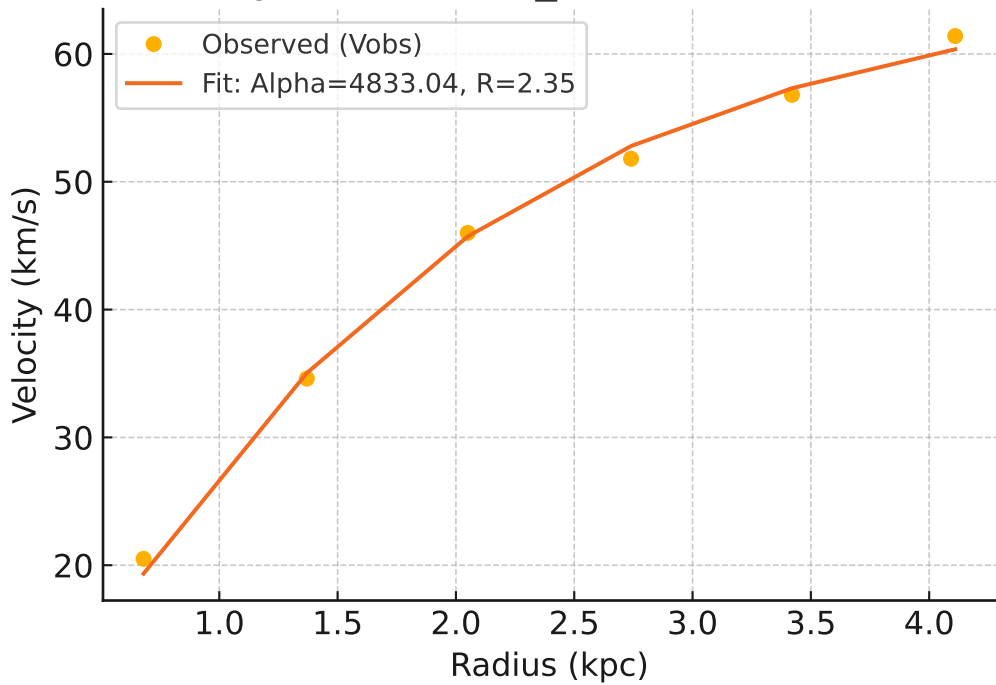
# Galaxy: UGC05005\_rotmod ( $R^2=0.990$ )



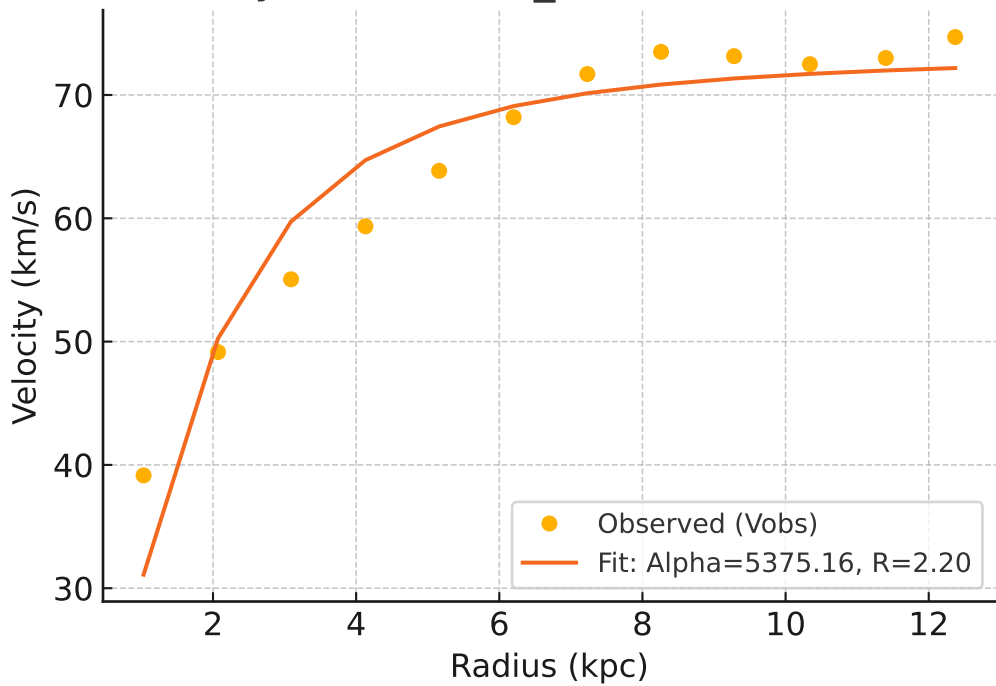
# Galaxy: UGC05253\_rotmod ( $R^2=-0.200$ )



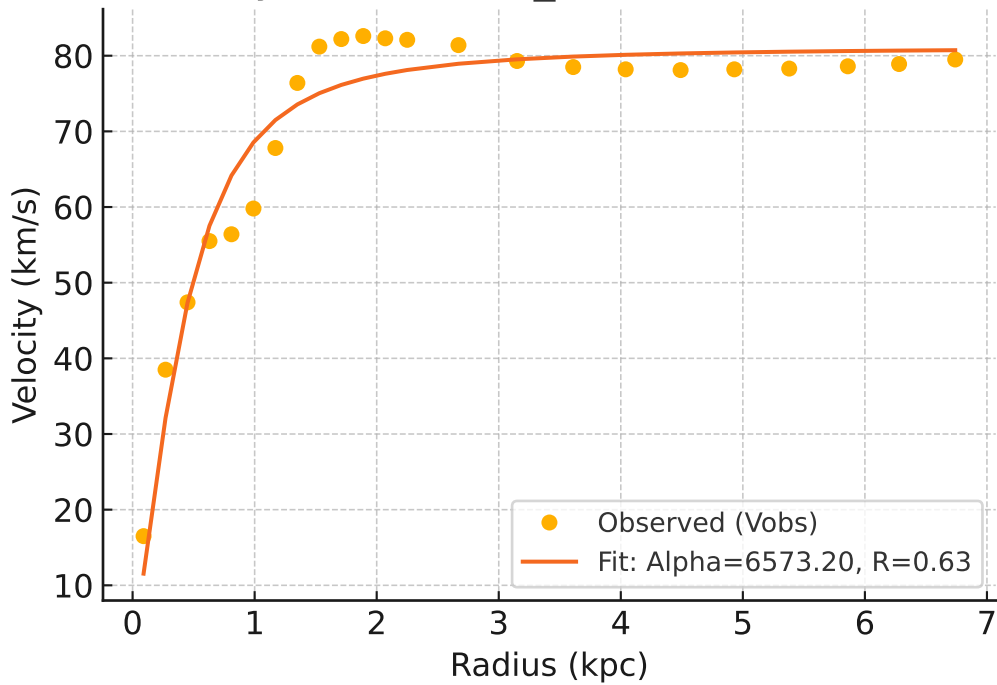
# Galaxy: UGC05414\_rotmod ( $R^2=0.997$ )



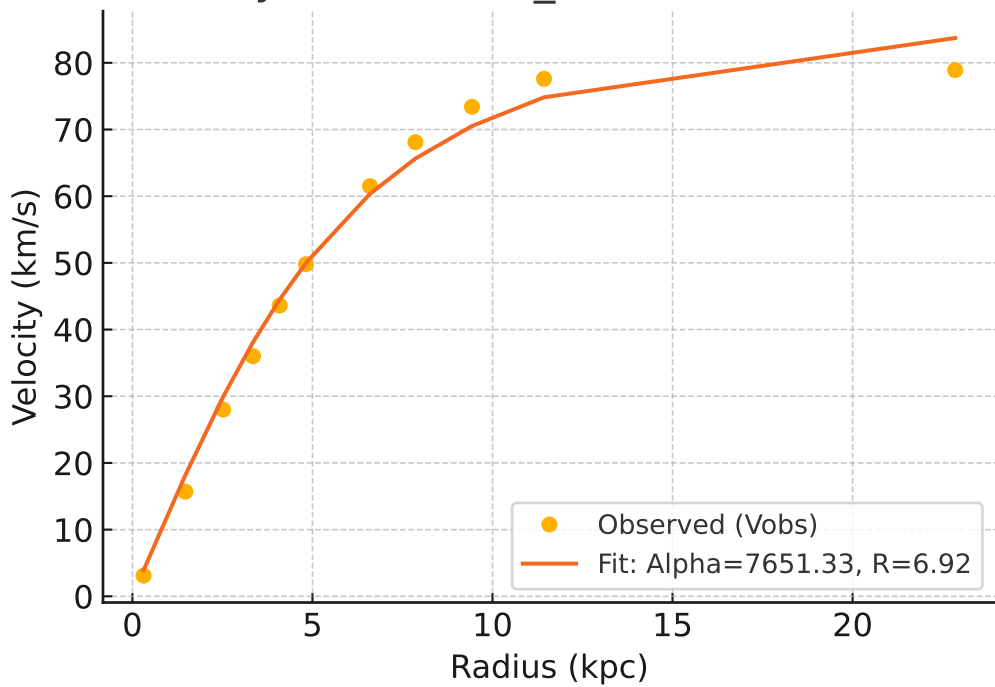
# Galaxy: UGC05716\_rotmod ( $R^2=0.896$ )



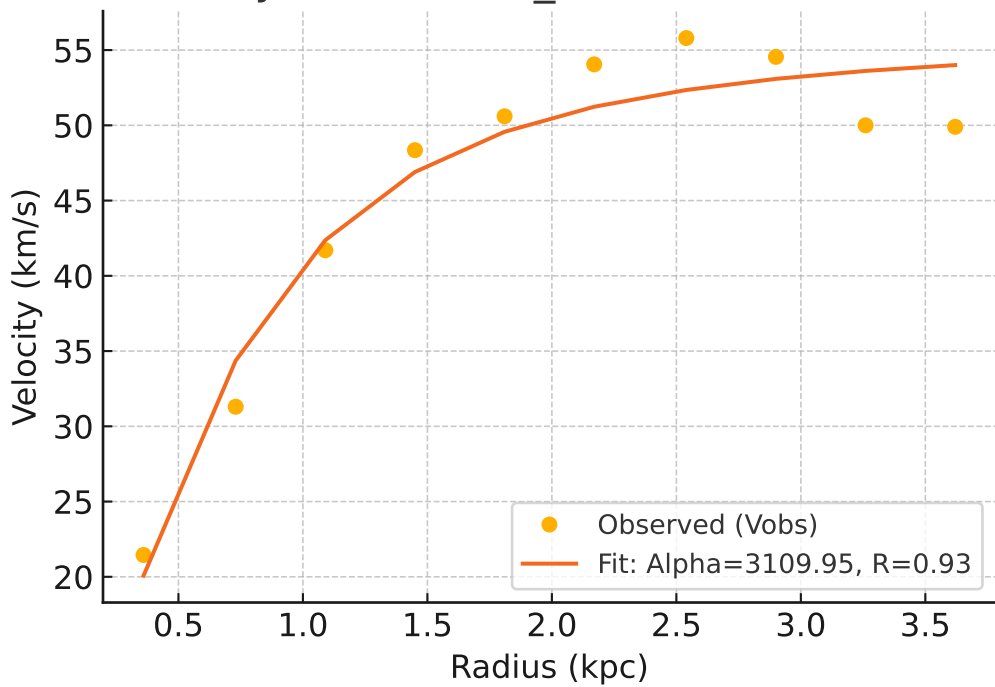
# Galaxy: UGC05721\_rotmod ( $R^2=0.937$ )



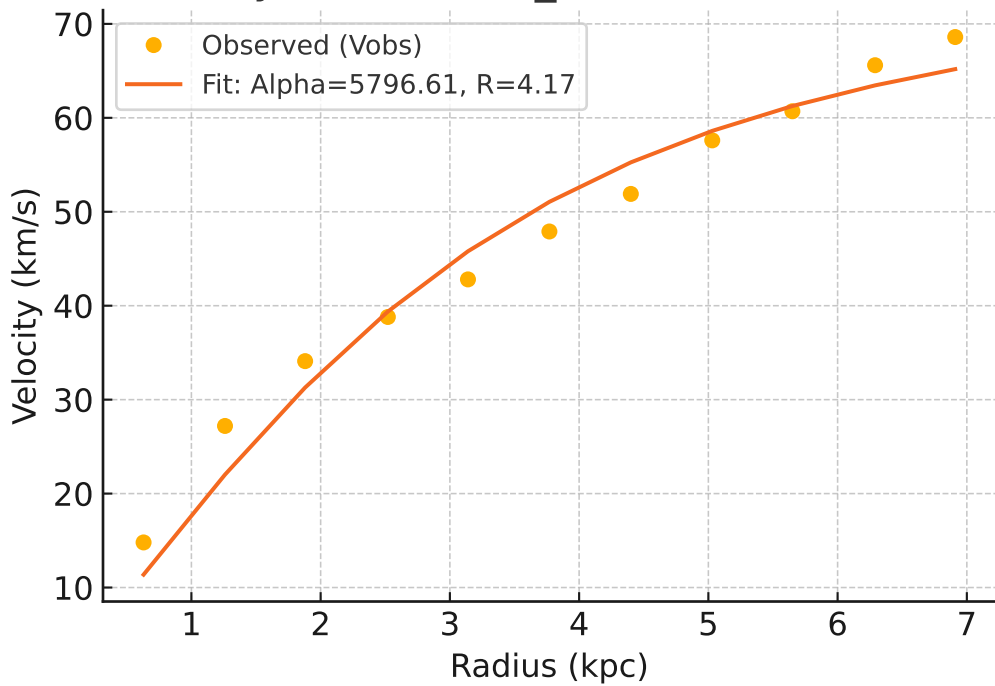
# Galaxy: UGC05750\_rotmod ( $R^2=0.991$ )



# Galaxy: UGC05764\_rotmod ( $R^2=0.941$ )

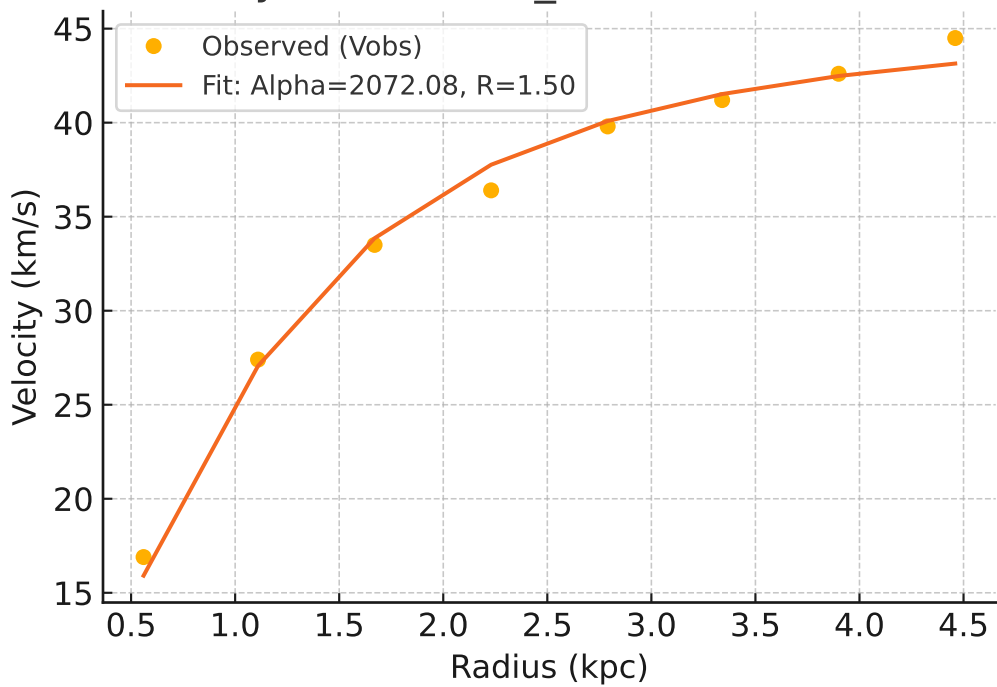


# Galaxy: UGC05829\_rotmod ( $R^2=0.966$ )

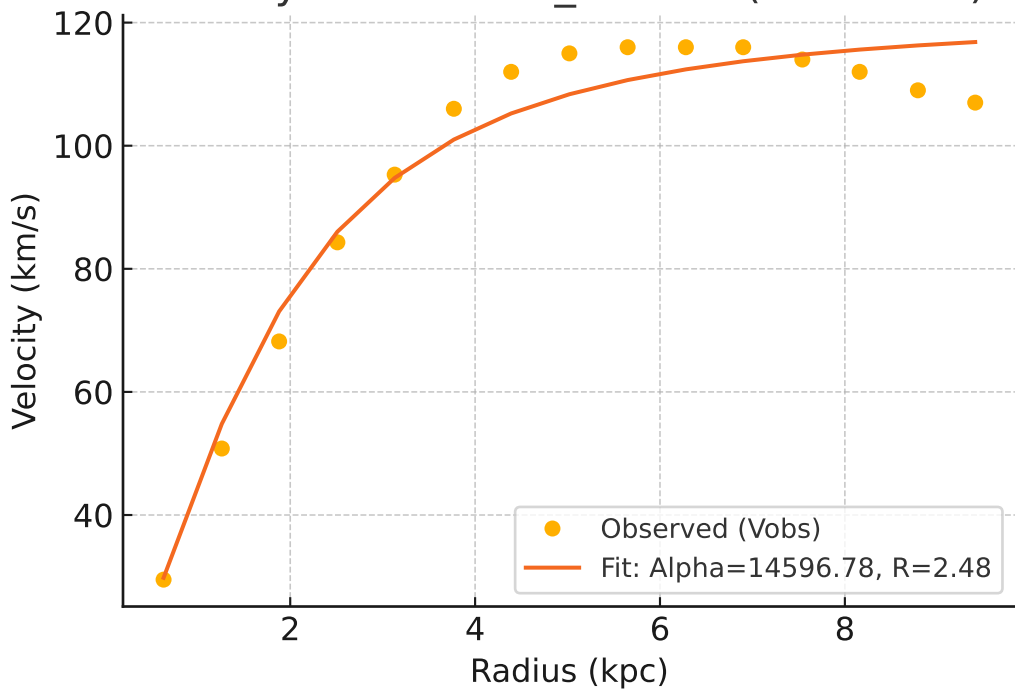




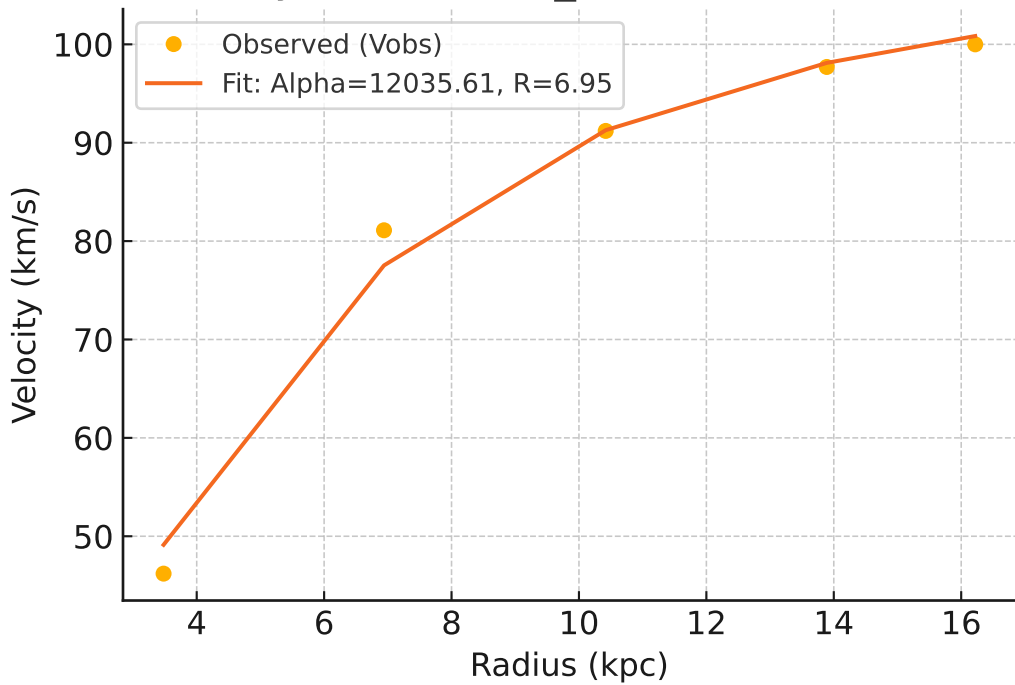
# Galaxy: UGC05918\_rotmod ( $R^2=0.991$ )



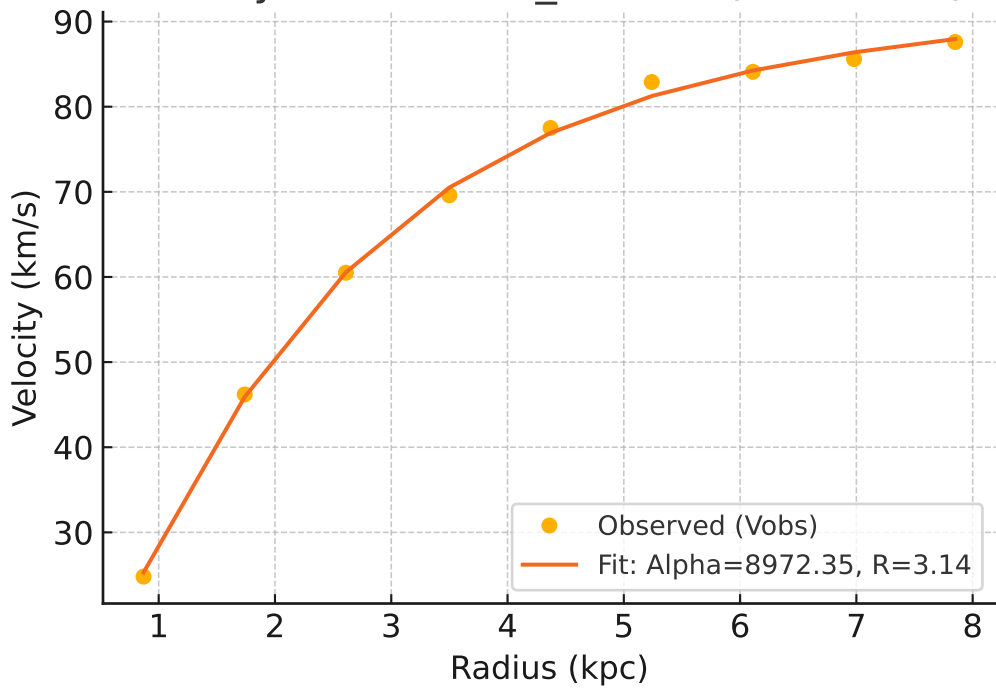
# Galaxy: UGC05986\_rotmod ( $R^2=0.964$ )



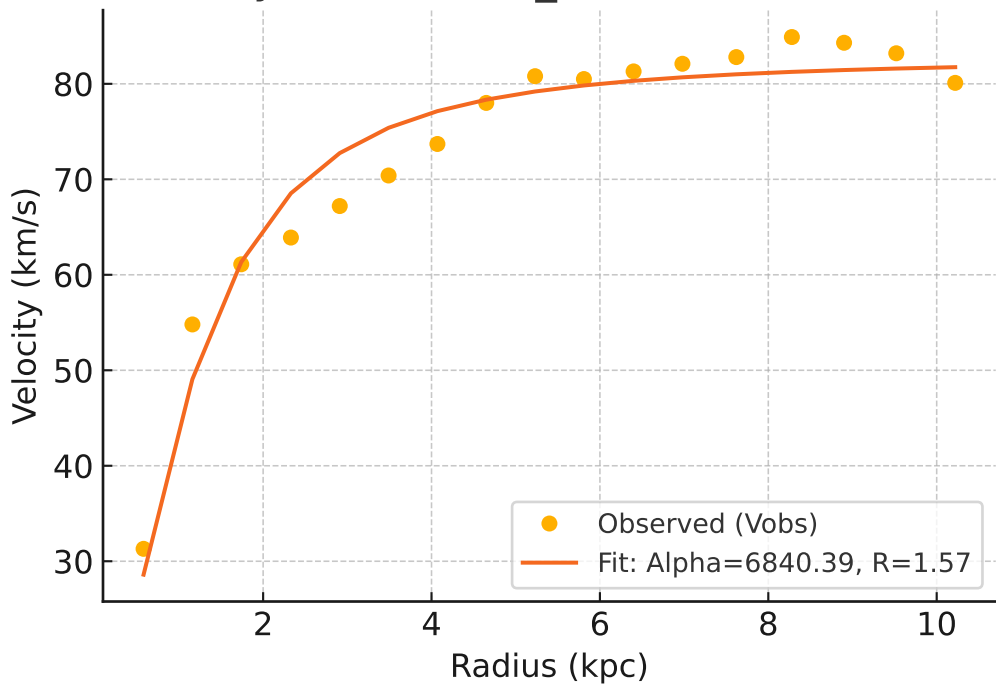
# Galaxy: UGC05999\_rotmod ( $R^2=0.988$ )



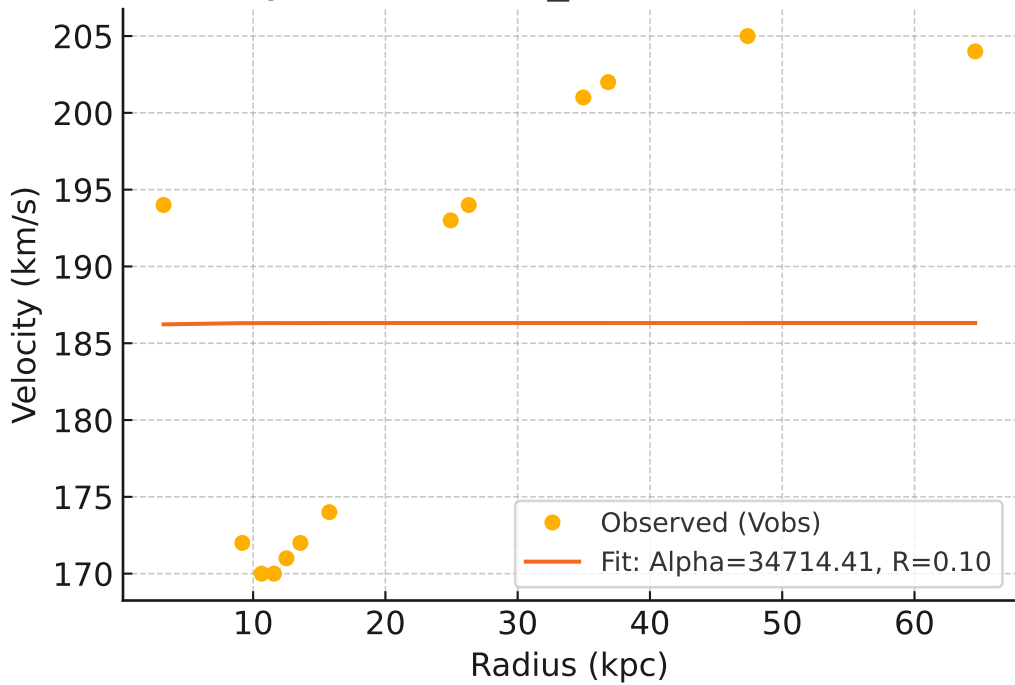
# Galaxy: UGC06399\_rotmod ( $R^2=0.999$ )



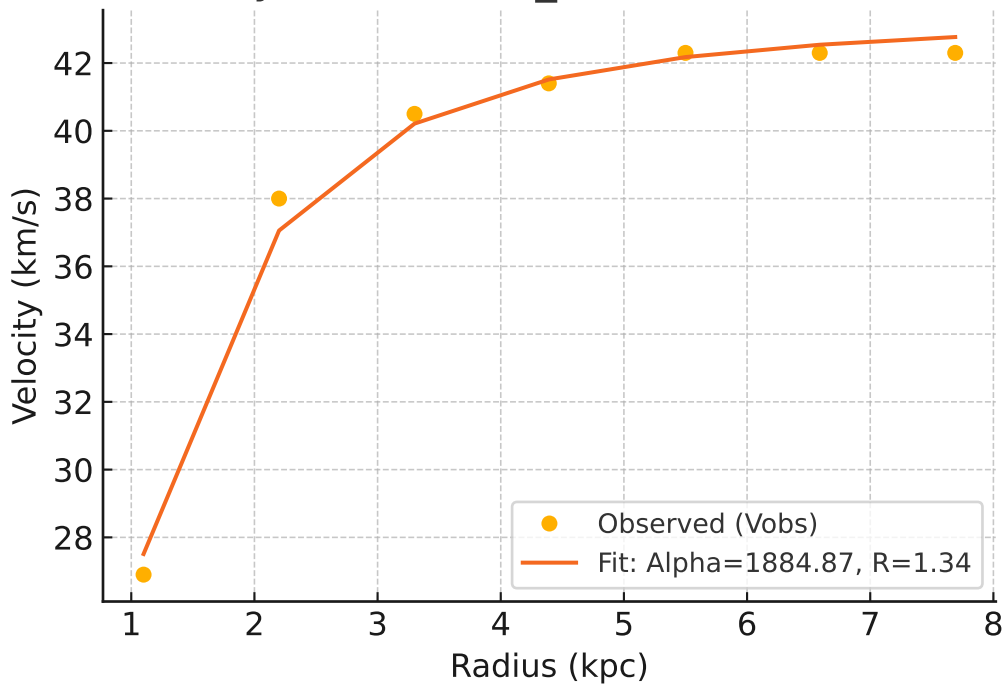
# Galaxy: UGC06446\_rotmod ( $R^2=0.947$ )



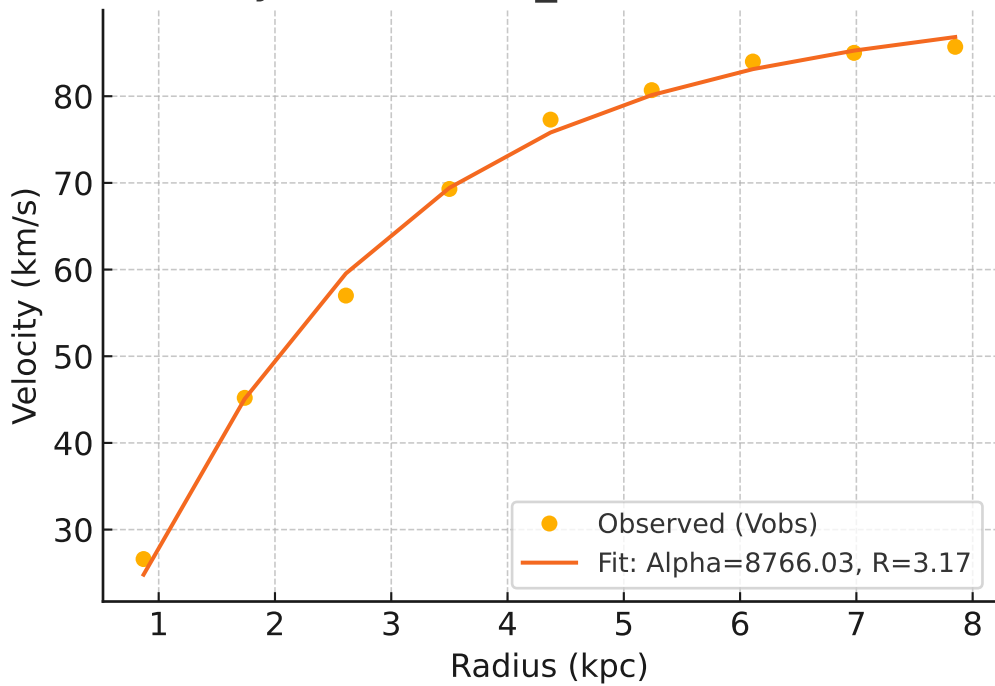
# Galaxy: UGC06614\_rotmod ( $R^2=-0.000$ )



# Galaxy: UGC06628\_rotmod ( $R^2=0.991$ )

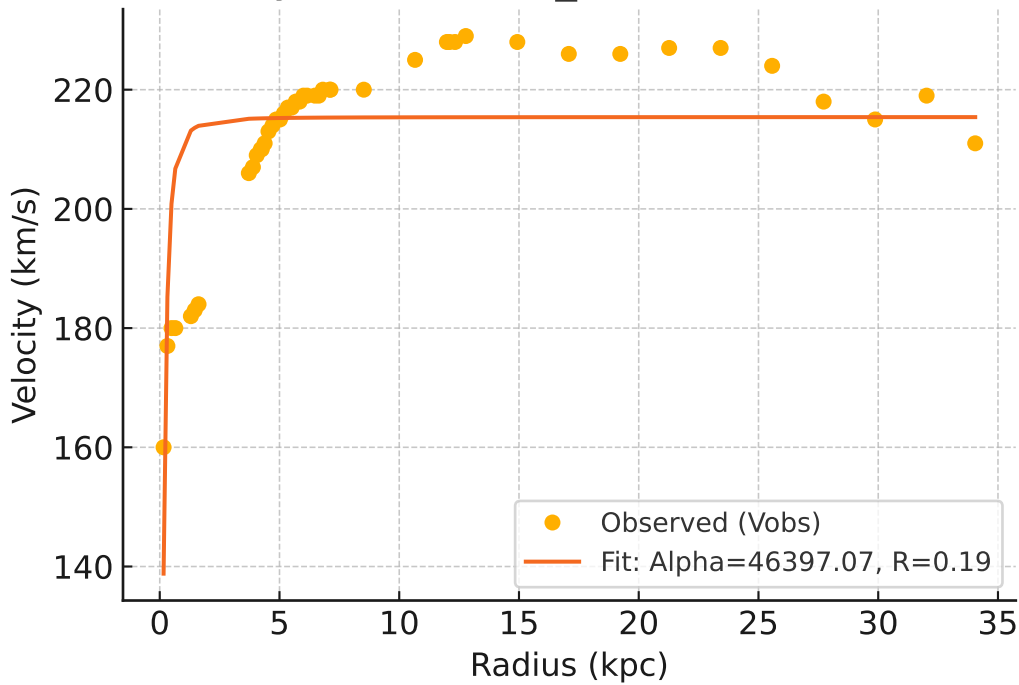


# Galaxy: UGC06667\_rotmod ( $R^2=0.996$ )

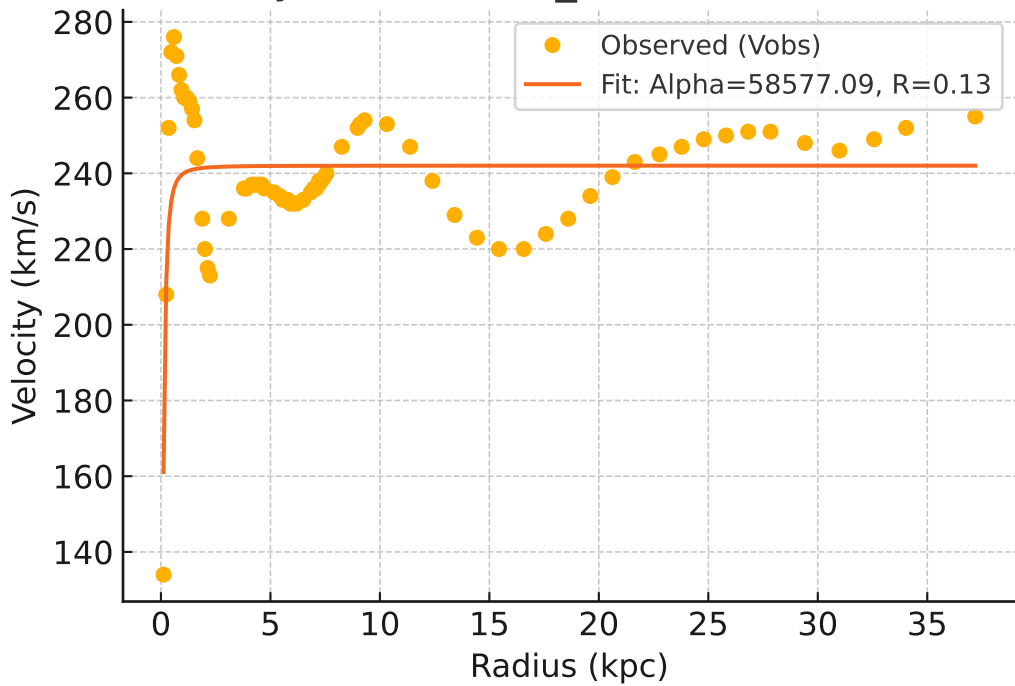




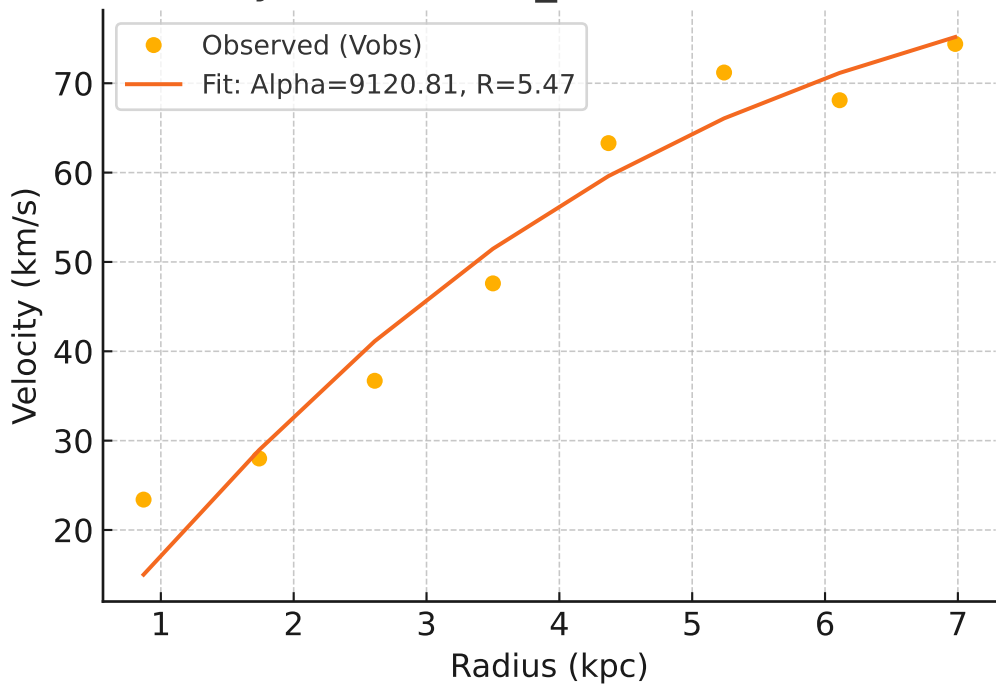
# Galaxy: UGC06786\_rotmod ( $R^2=0.453$ )



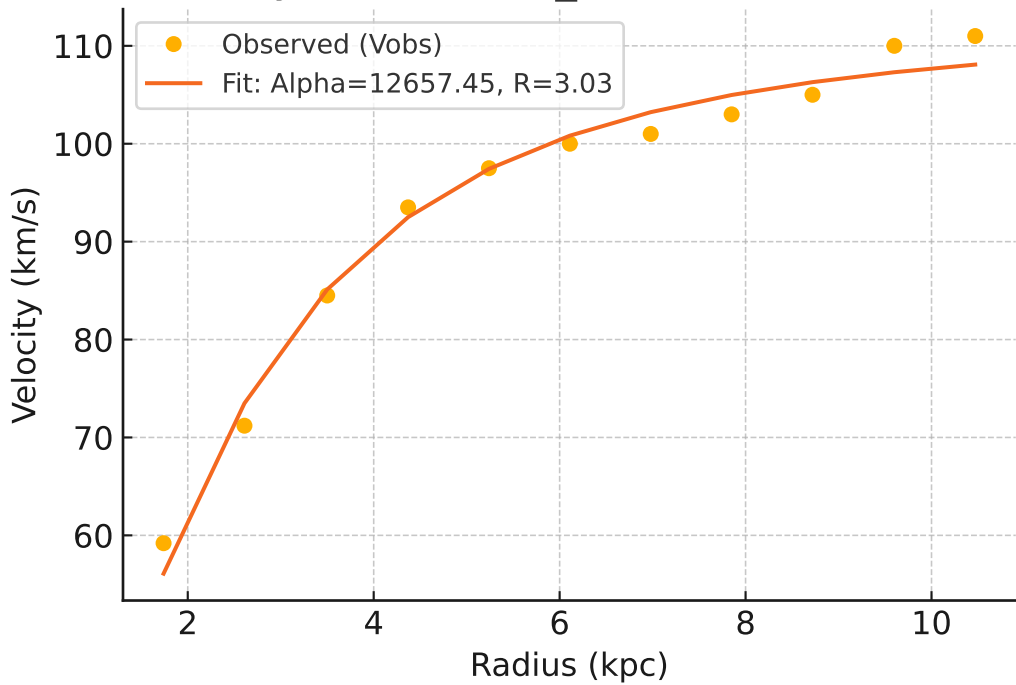
# Galaxy: UGC06787\_rotmod ( $R^2=0.380$ )



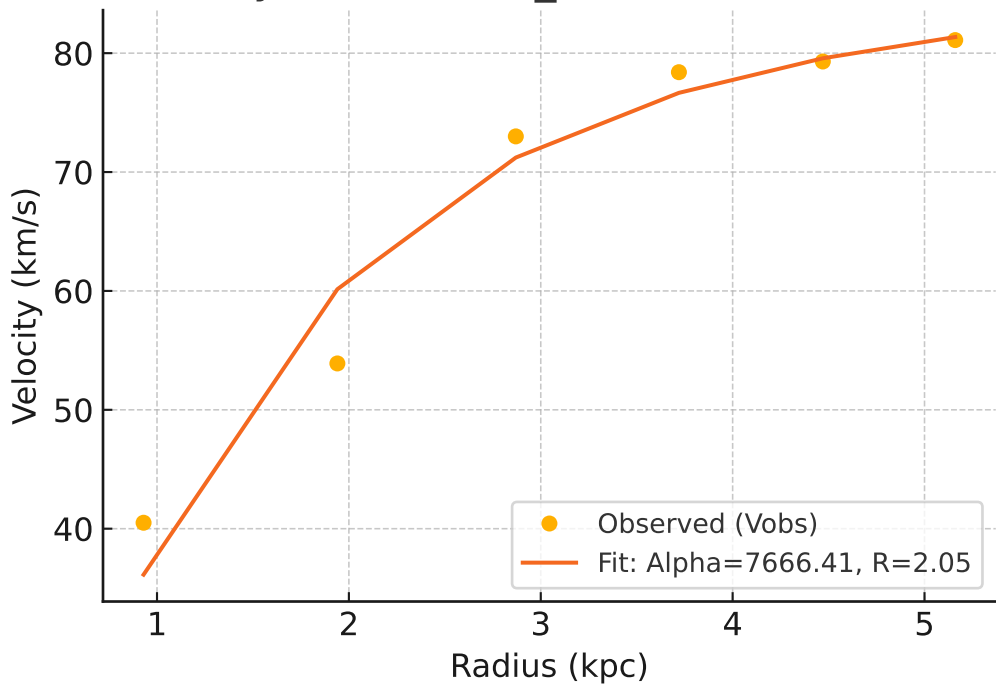
# Galaxy: UGC06818\_rotmod ( $R^2=0.946$ )



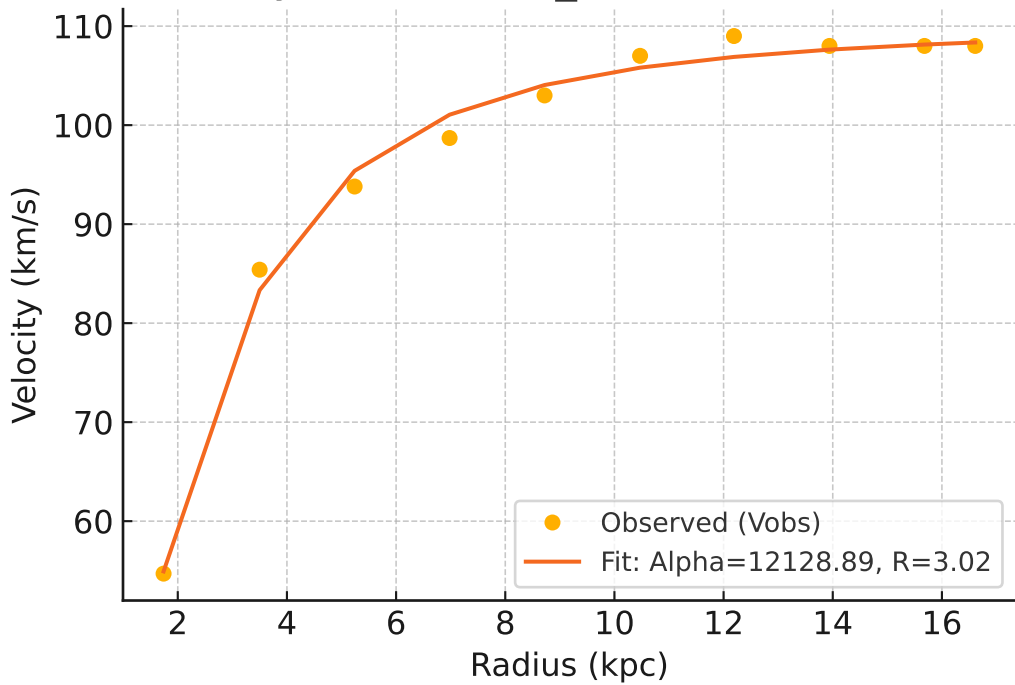
# Galaxy: UGC06917\_rotmod ( $R^2=0.984$ )



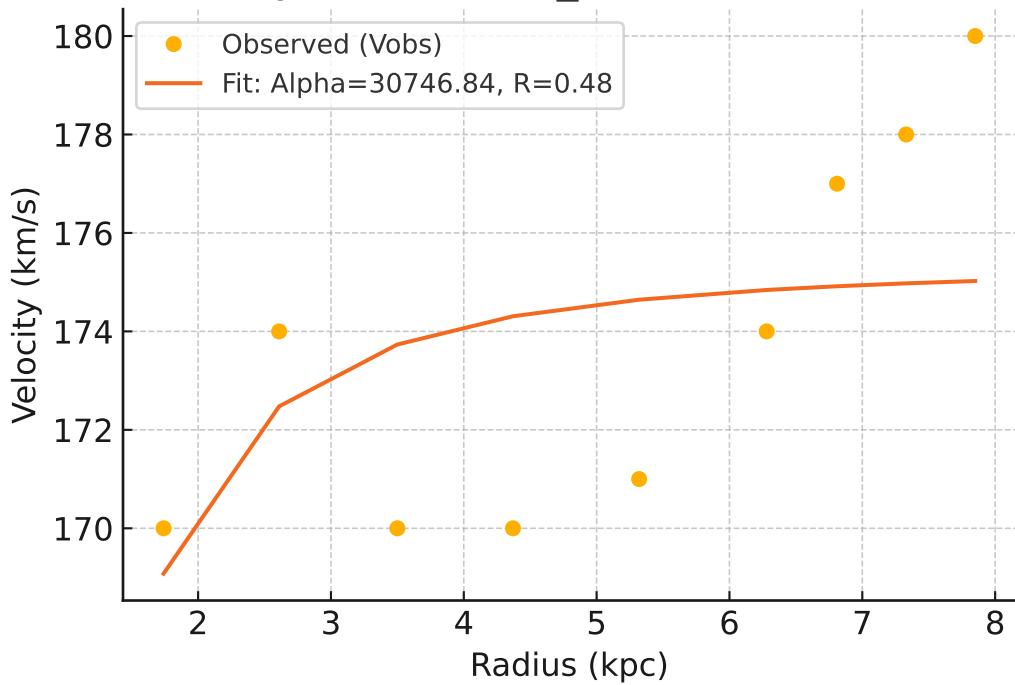
# Galaxy: UGC06923\_rotmod ( $R^2=0.954$ )



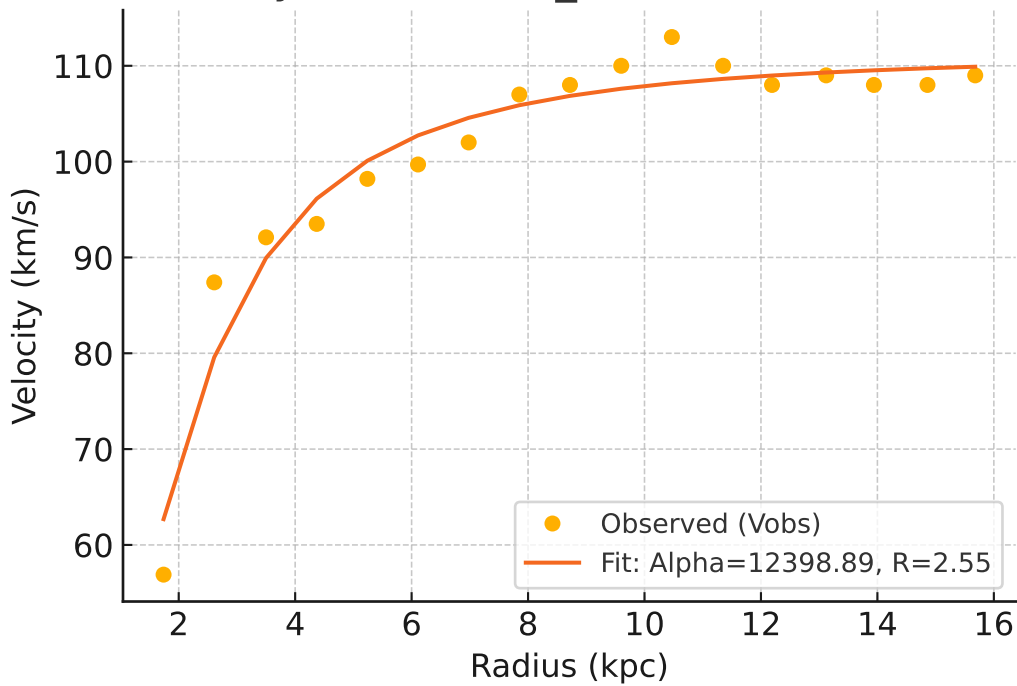
# Galaxy: UGC06930\_rotmod ( $R^2=0.992$ )



# Galaxy: UGC06973\_rotmod ( $R^2=0.252$ )

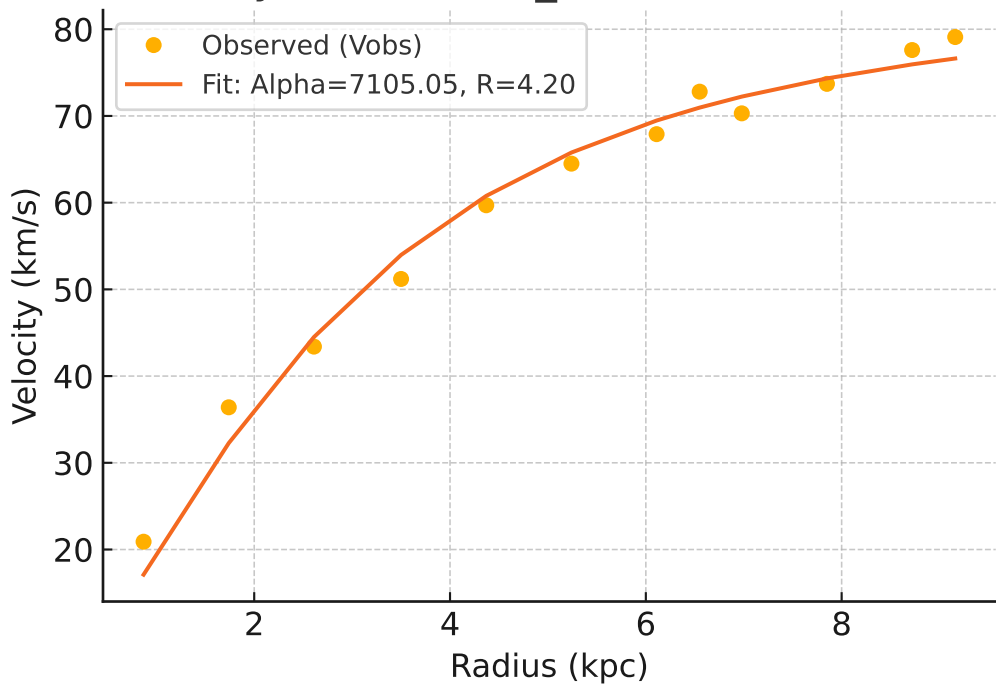


# Galaxy: UGC06983\_rotmod ( $R^2=0.943$ )

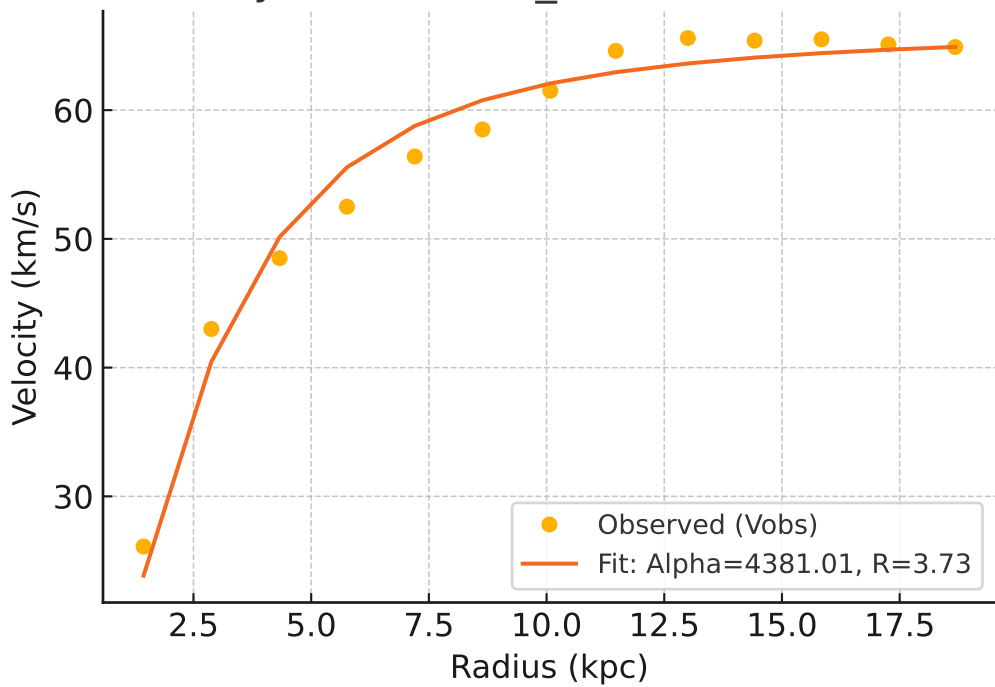




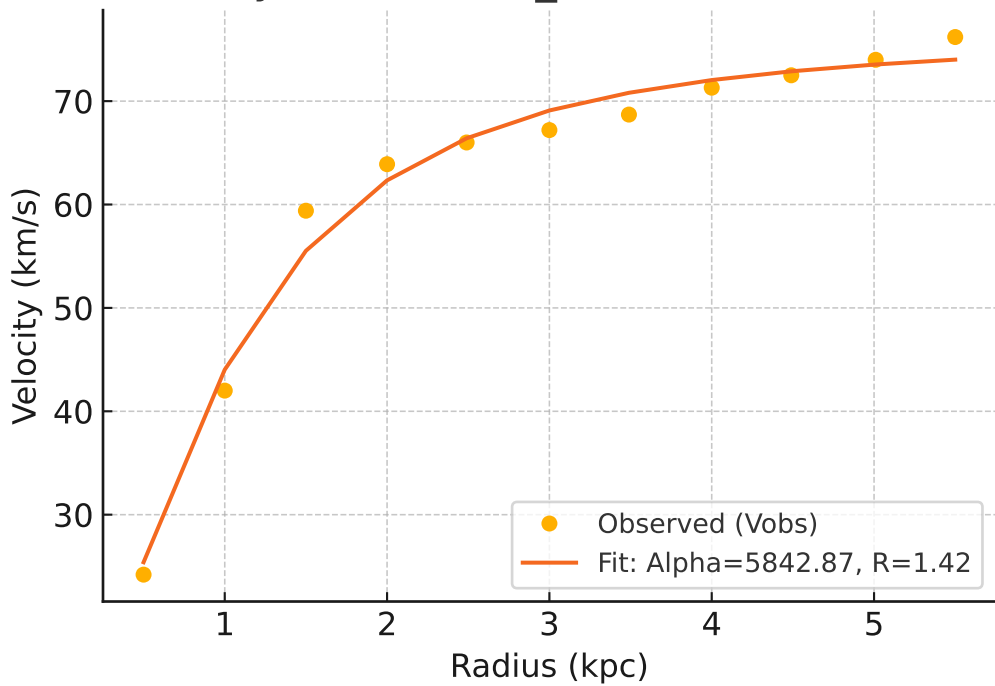
# Galaxy: UGC07089\_rotmod ( $R^2=0.983$ )



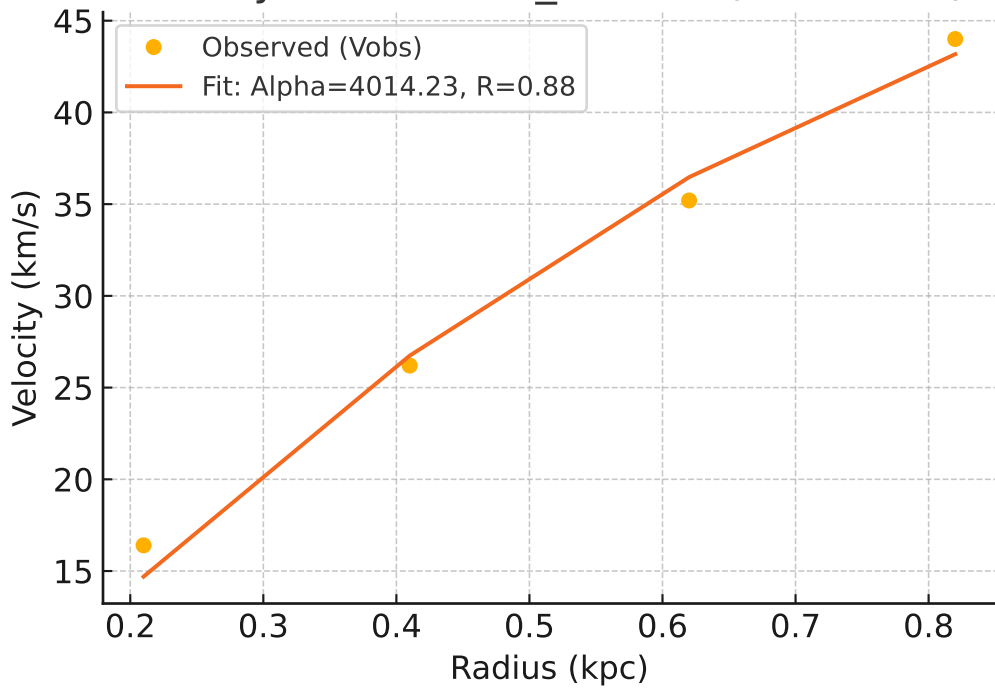
# Galaxy: UGC07125\_rotmod ( $R^2=0.973$ )



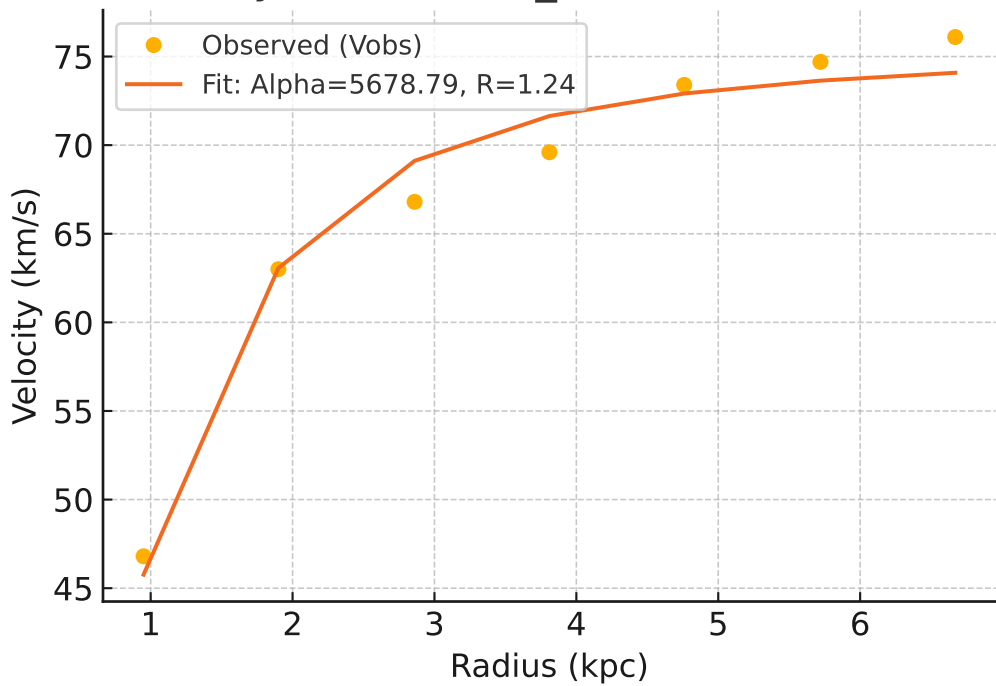
# Galaxy: UGC07151\_rotmod ( $R^2=0.985$ )



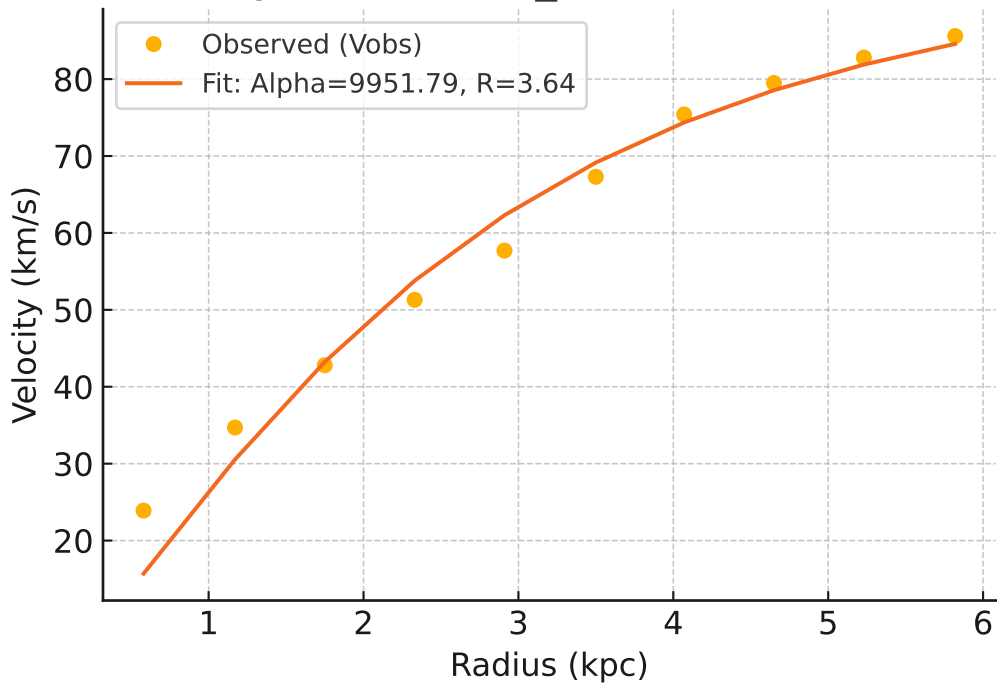
# Galaxy: UGC07232\_rotmod ( $R^2=0.987$ )



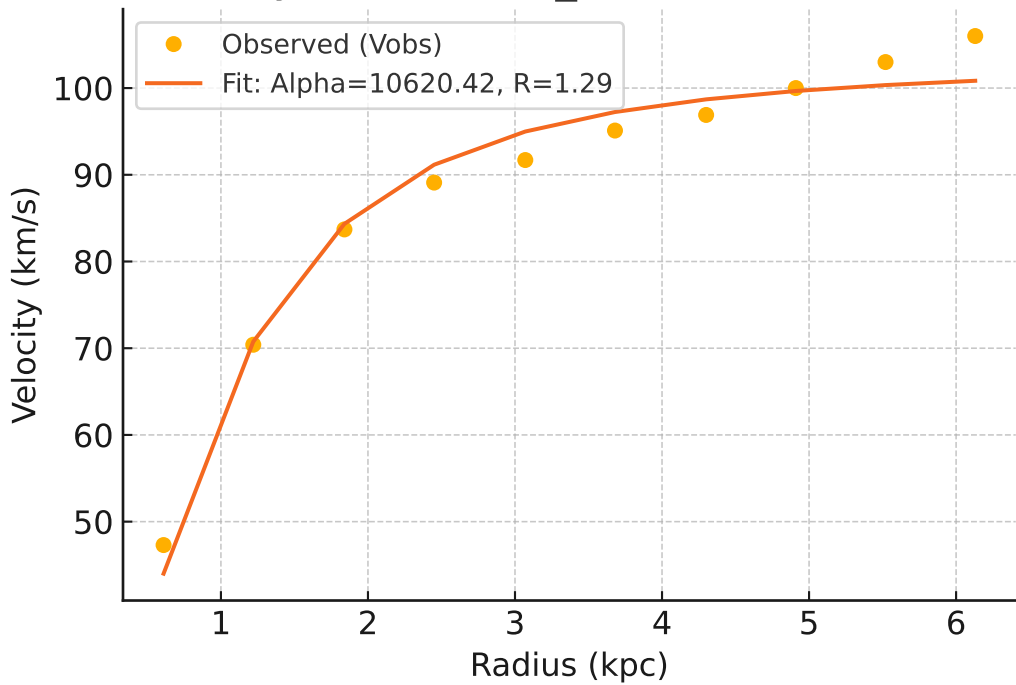
# Galaxy: UGC07261\_rotmod ( $R^2=0.974$ )



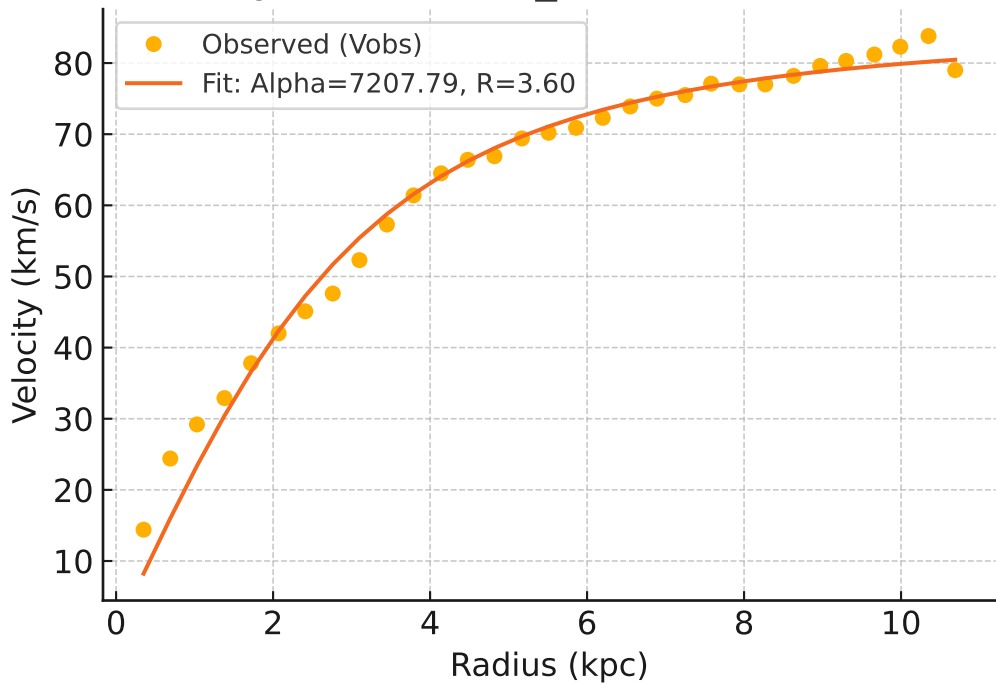
# Galaxy: UGC07323\_rotmod ( $R^2=0.971$ )



# Galaxy: UGC07399\_rotmod ( $R^2=0.976$ )

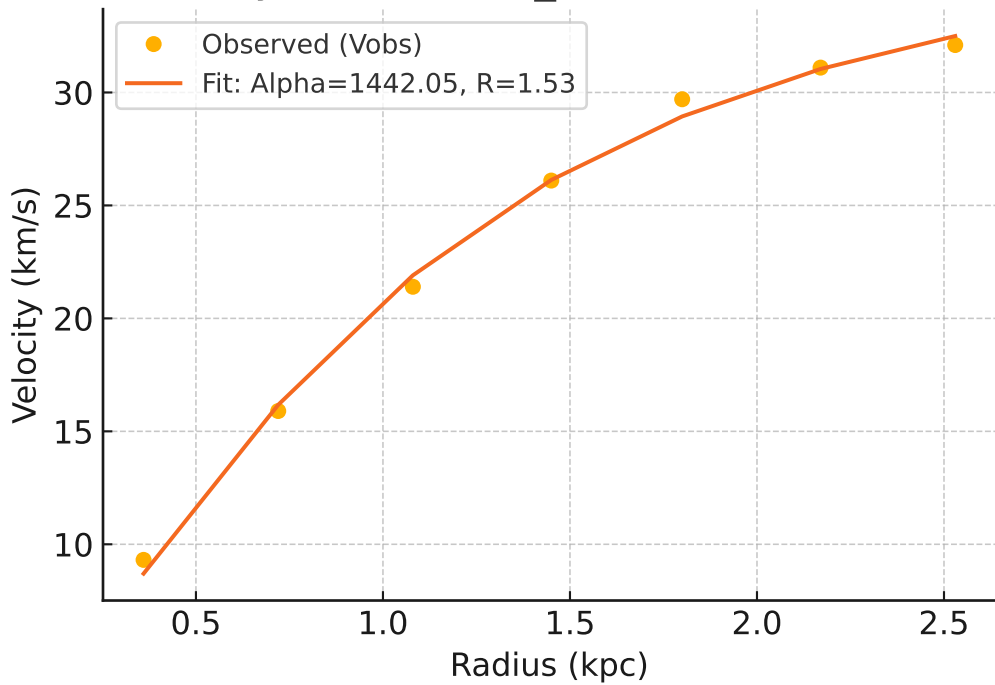


# Galaxy: UGC07524\_rotmod ( $R^2=0.981$ )

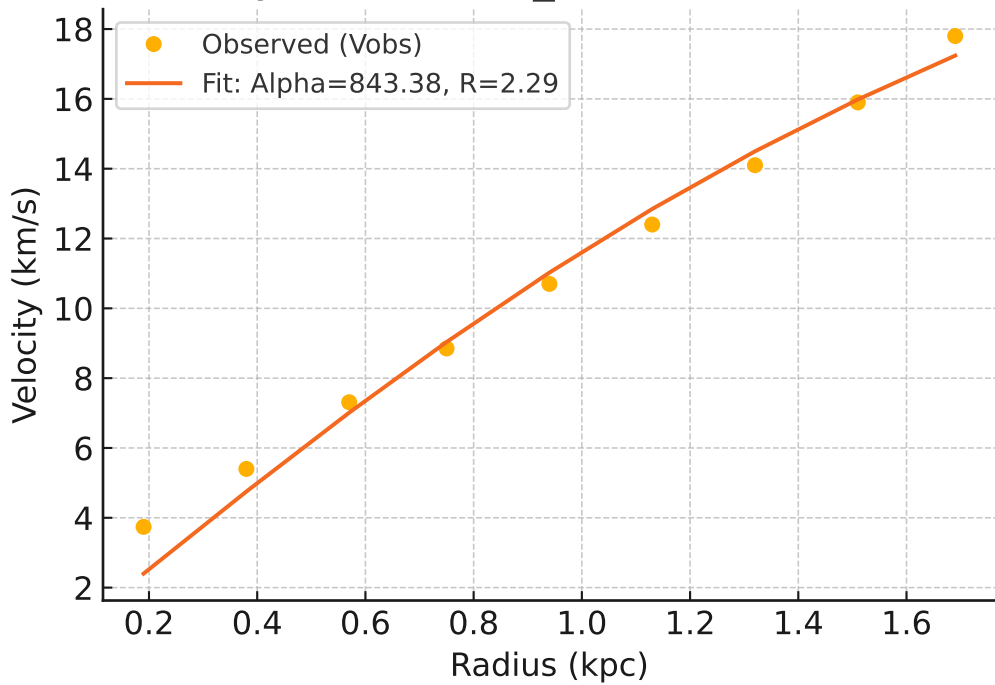




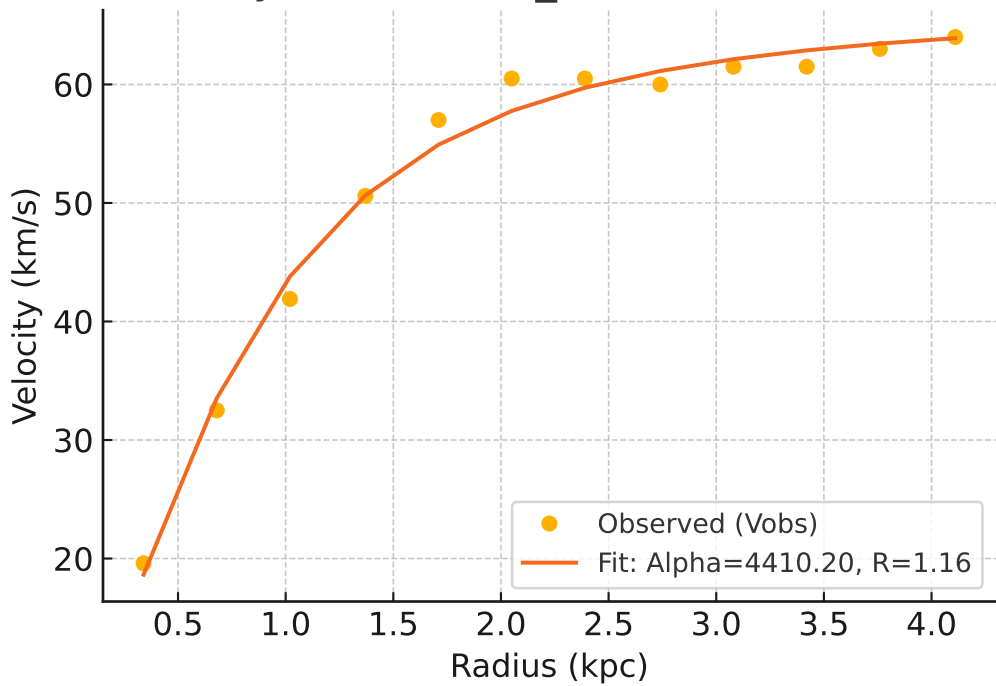
# Galaxy: UGC07559\_rotmod ( $R^2=0.997$ )



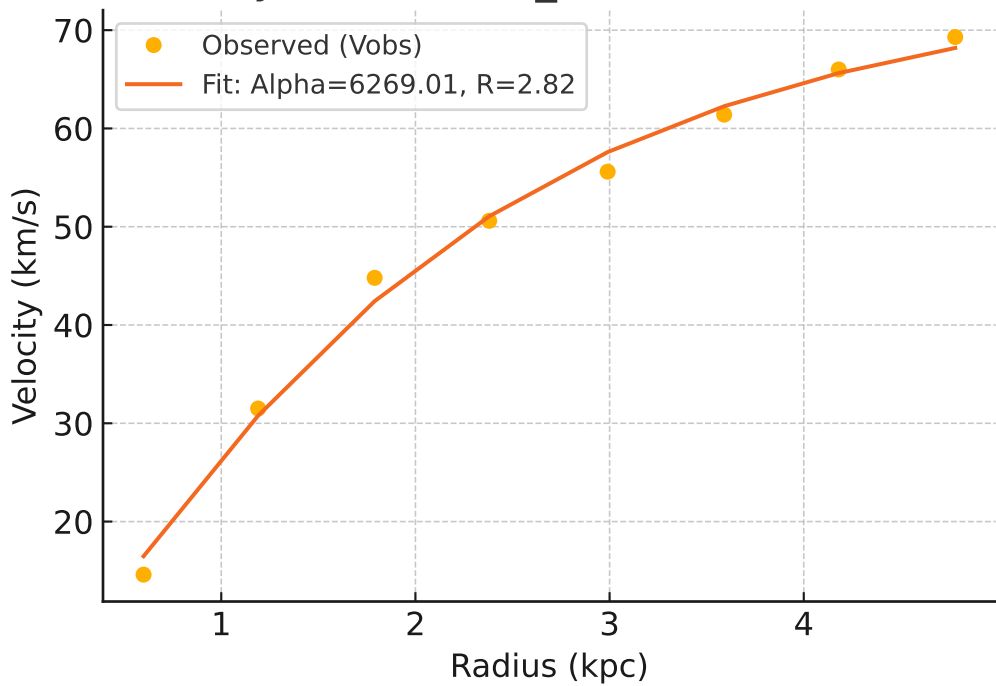
# Galaxy: UGC07577\_rotmod ( $R^2=0.983$ )



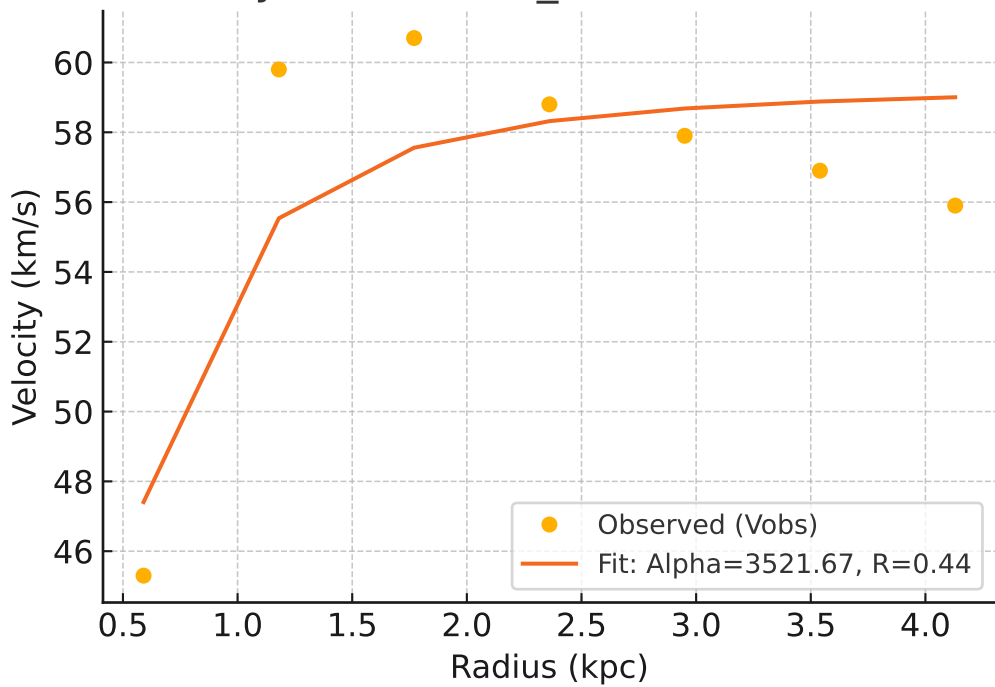
# Galaxy: UGC07603\_rotmod ( $R^2=0.990$ )



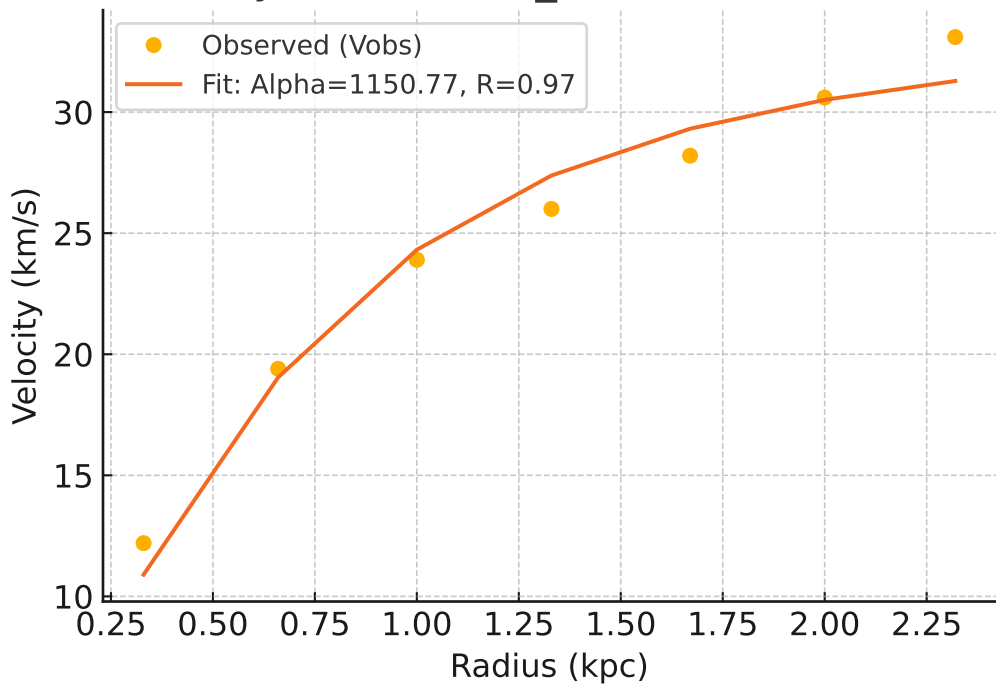
# Galaxy: UGC07608\_rotmod ( $R^2=0.993$ )



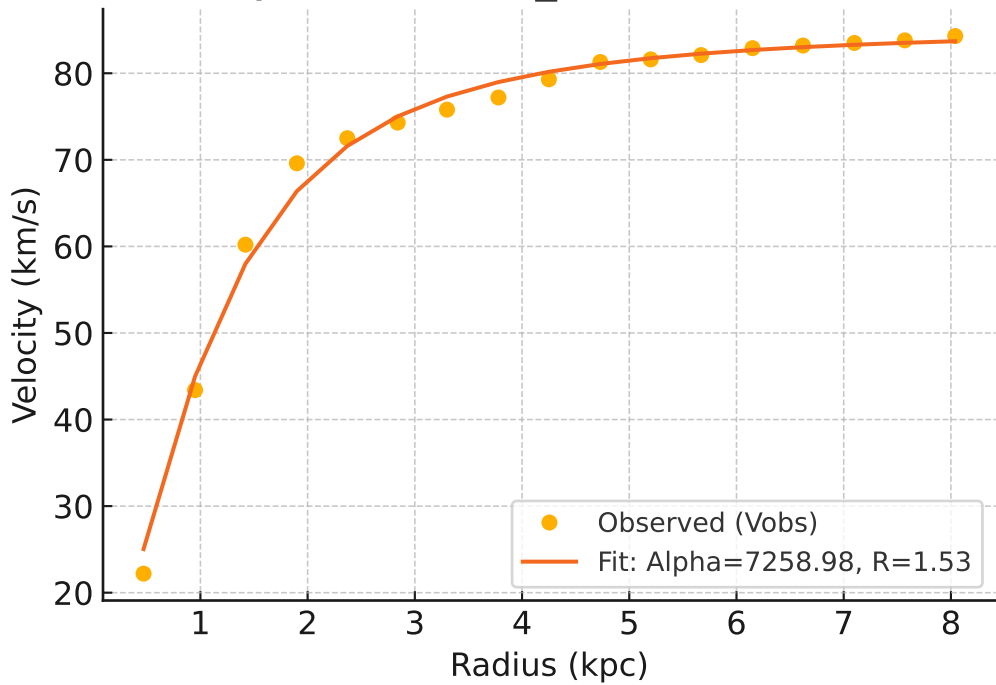
# Galaxy: UGC07690\_rotmod ( $R^2=0.710$ )



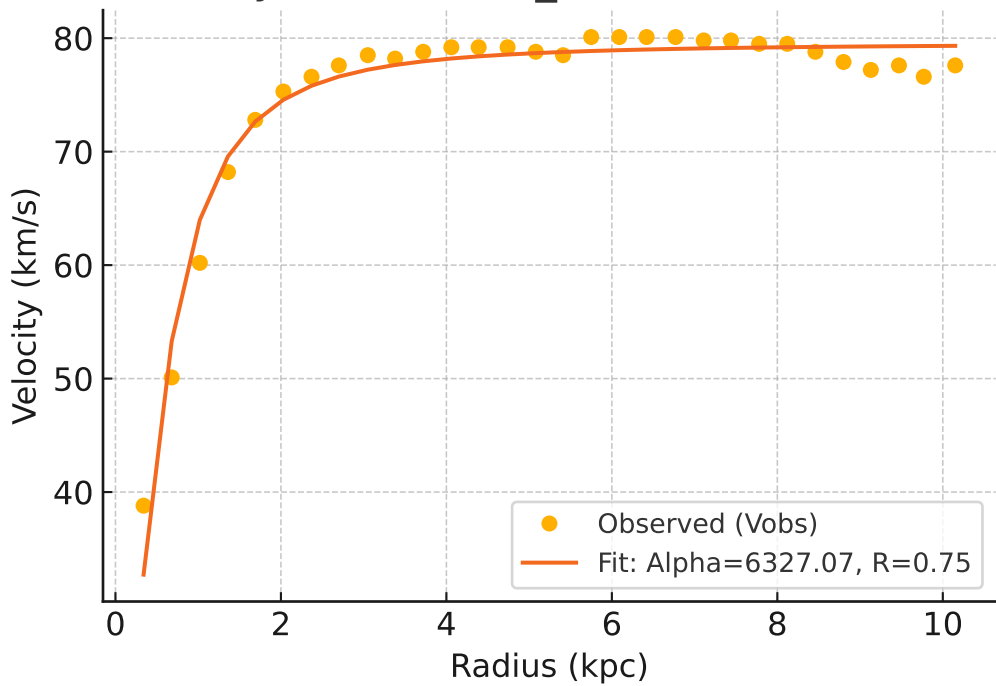
# Galaxy: UGC07866\_rotmod ( $R^2=0.972$ )



# Galaxy: UGC08286\_rotmod ( $R^2=0.992$ )

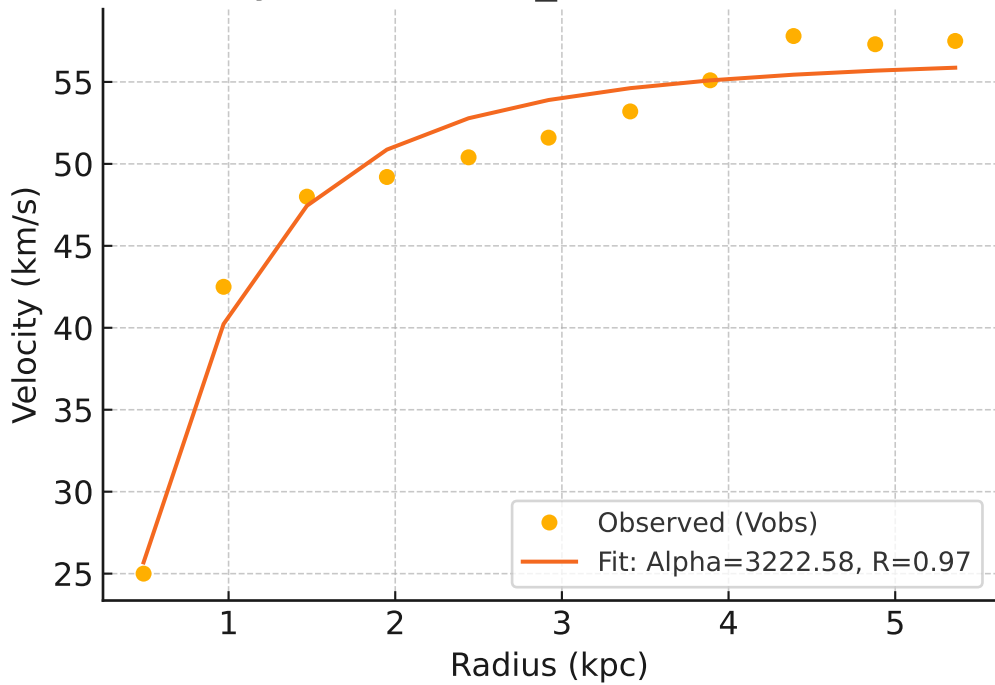


# Galaxy: UGC08490\_rotmod ( $R^2=0.962$ )

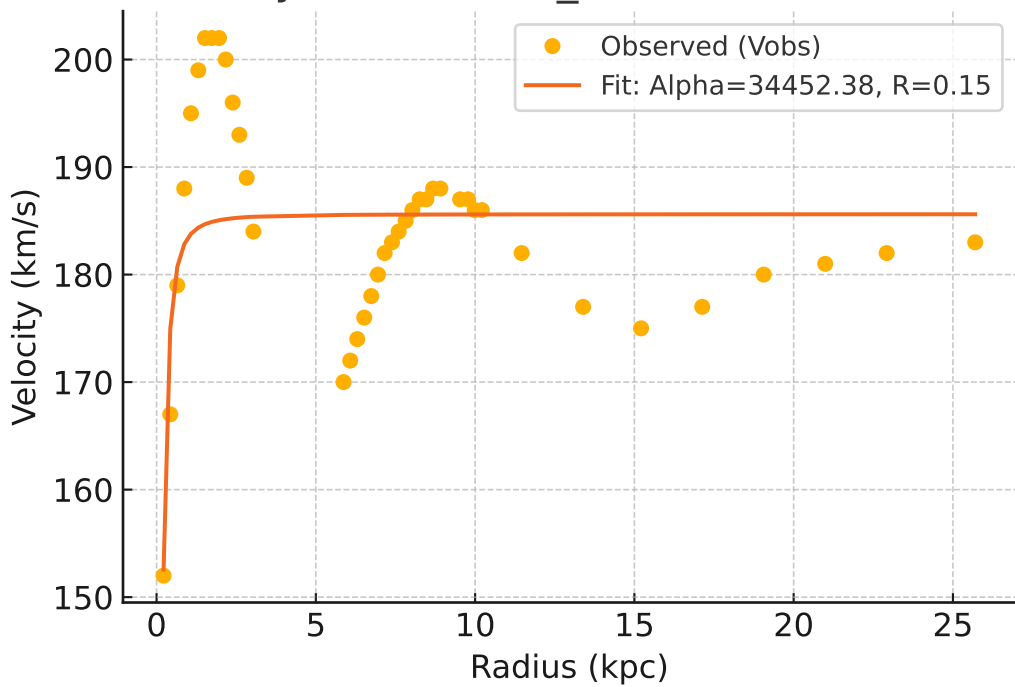




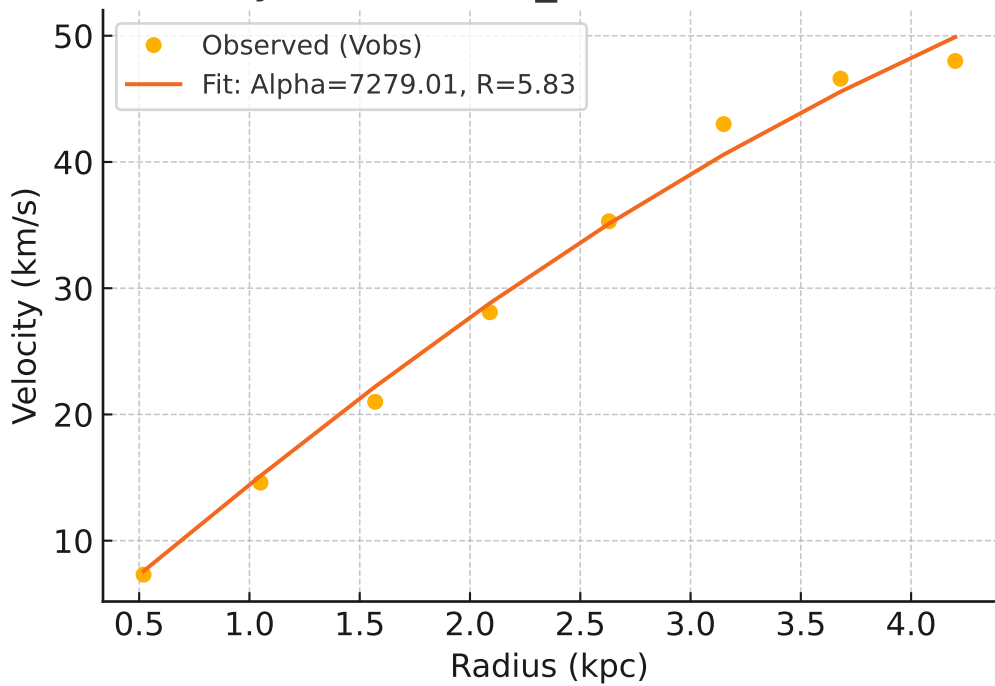
# Galaxy: UGC08550\_rotmod ( $R^2=0.964$ )



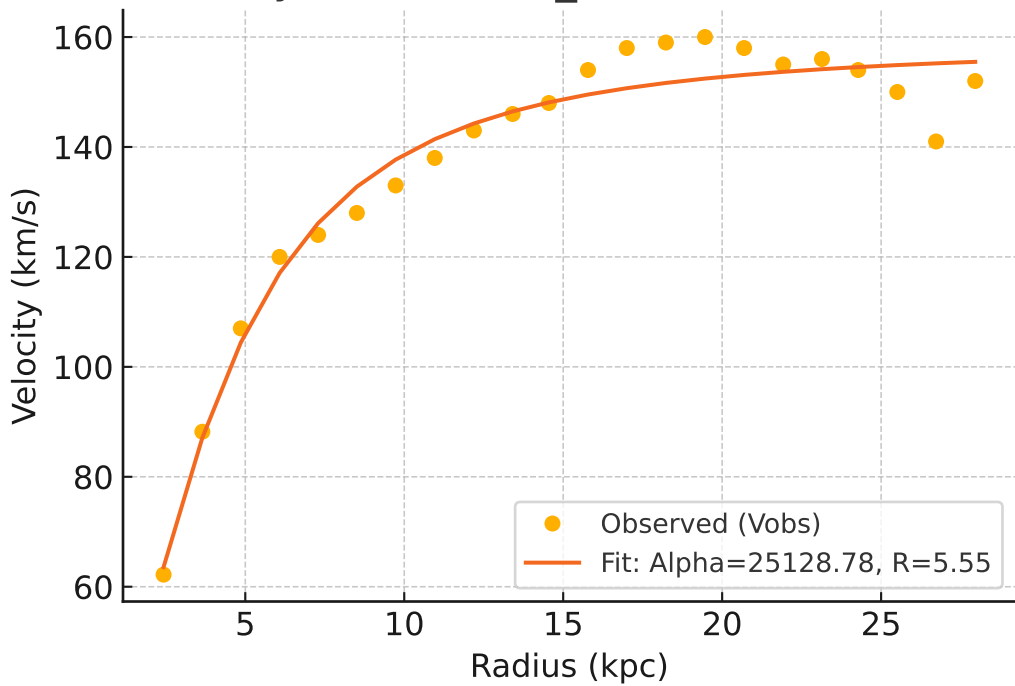
# Galaxy: UGC08699\_rotmod ( $R^2=0.293$ )



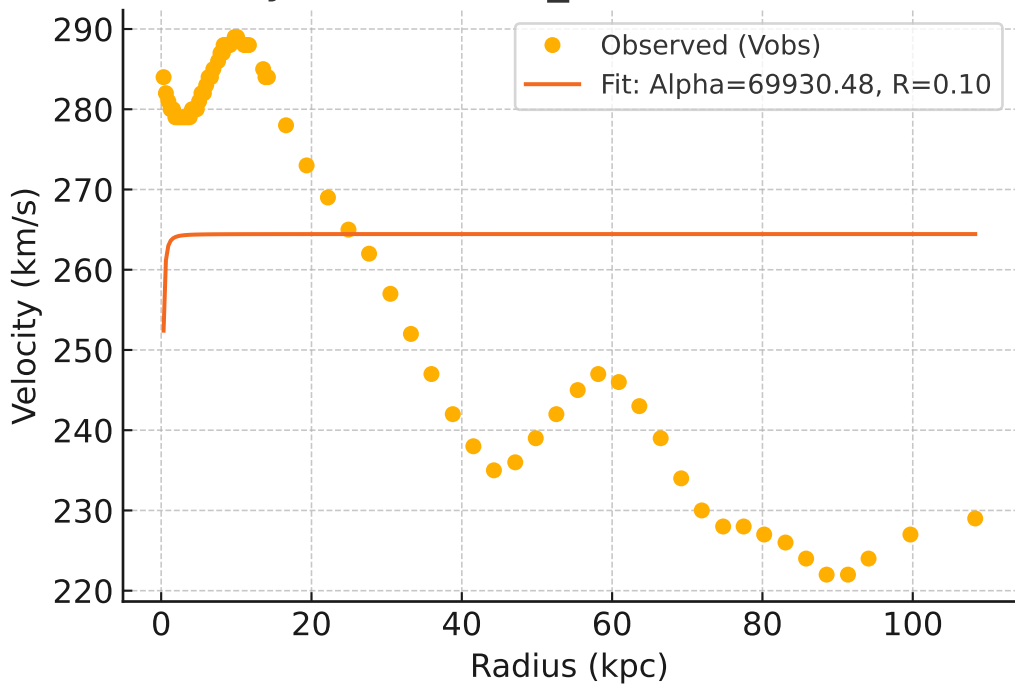
# Galaxy: UGC08837\_rotmod ( $R^2=0.992$ )



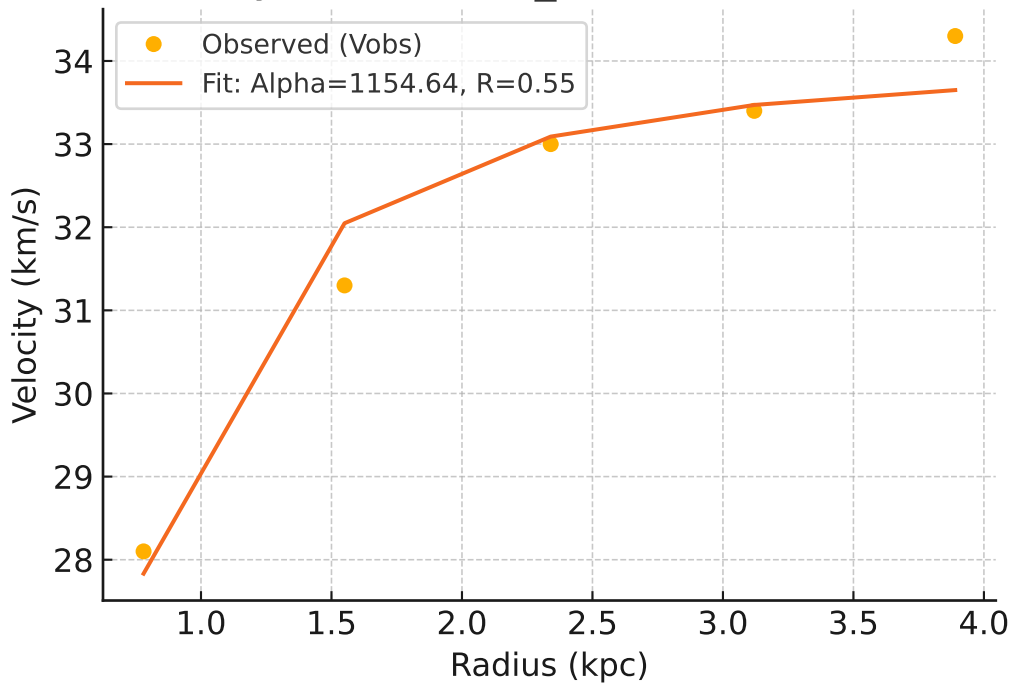
# Galaxy: UGC09037\_rotmod ( $R^2=0.960$ )



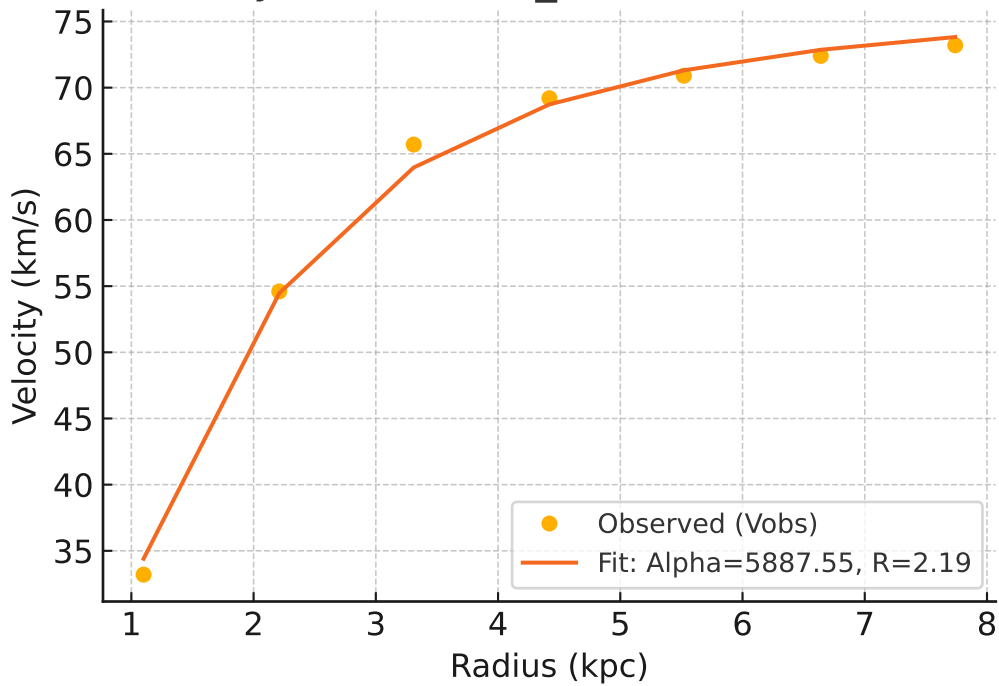
# Galaxy: UGC09133\_rotmod ( $R^2=-0.024$ )



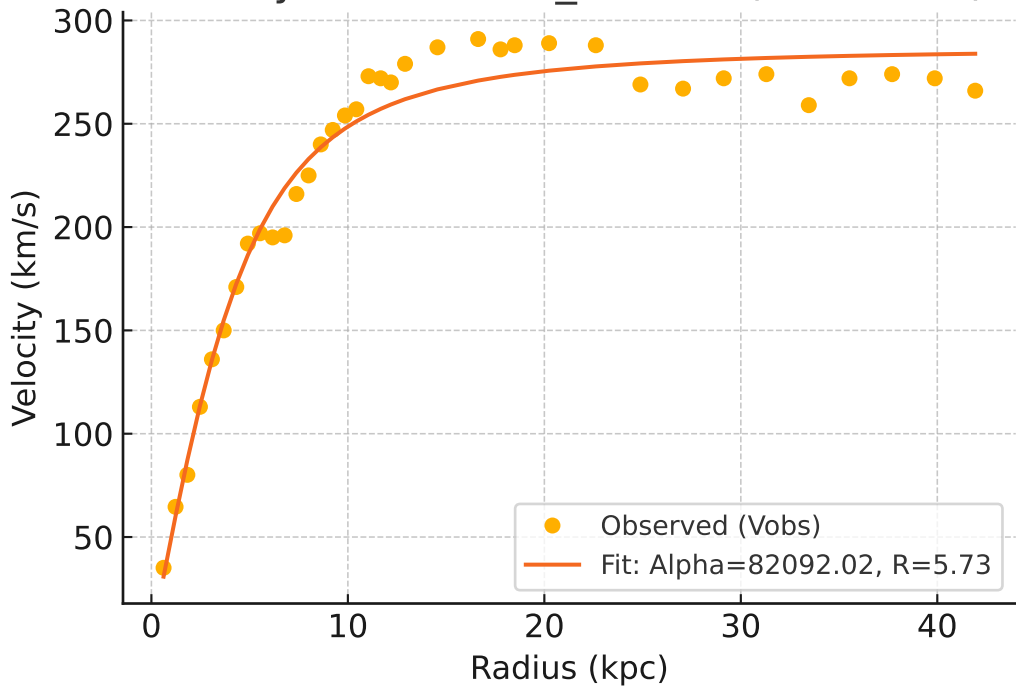
# Galaxy: UGC09992\_rotmod ( $R^2=0.955$ )



# Galaxy: UGC10310\_rotmod ( $R^2=0.996$ )

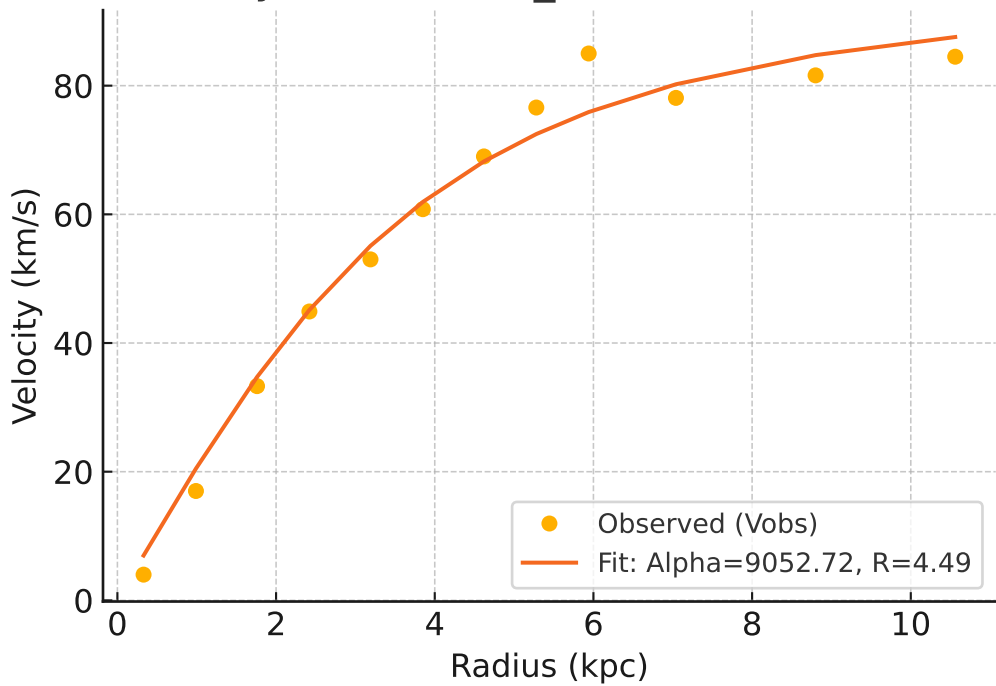


# Galaxy: UGC11455\_rotmod ( $R^2=0.969$ )

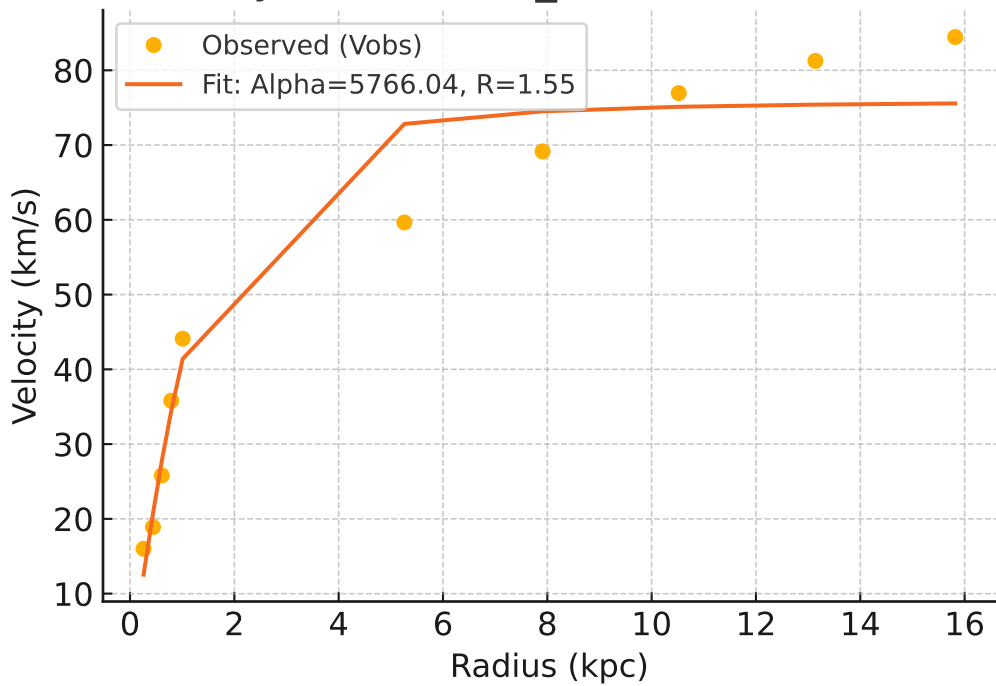




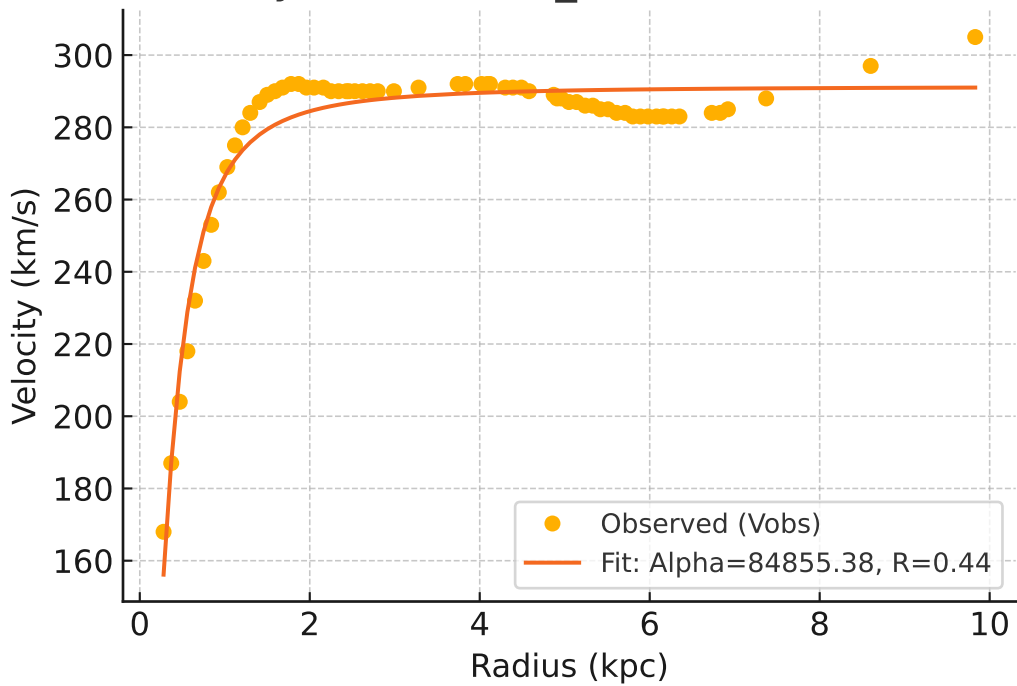
# Galaxy: UGC11557\_rotmod ( $R^2=0.981$ )



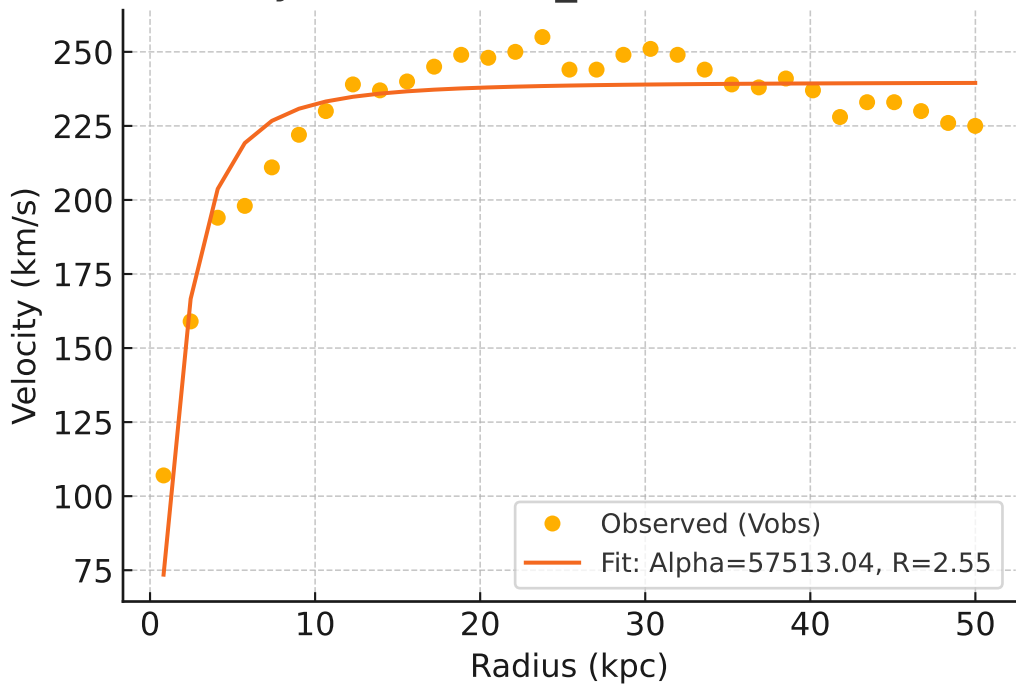
# Galaxy: UGC11820\_rotmod ( $R^2=0.945$ )



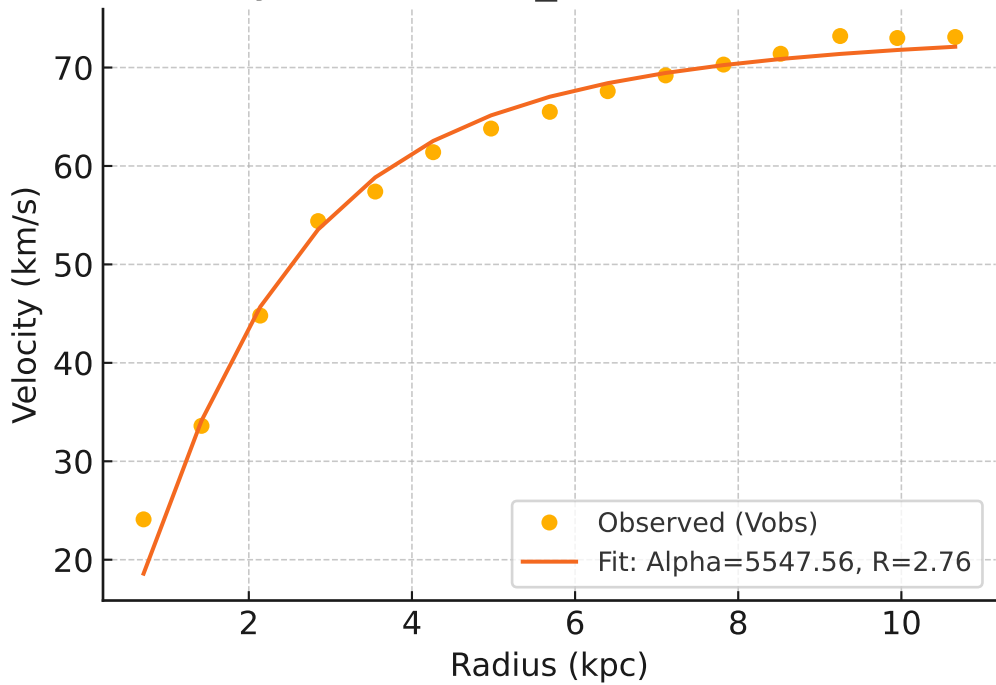
# Galaxy: UGC11914\_rotmod ( $R^2=0.941$ )



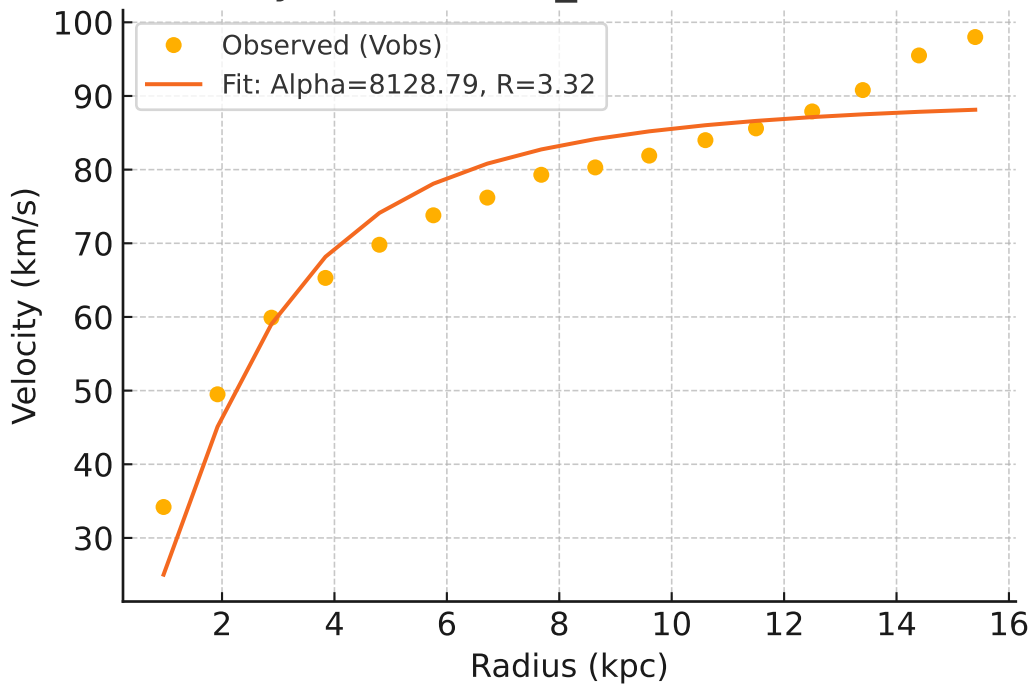
# Galaxy: UGC12506\_rotmod ( $R^2=0.856$ )



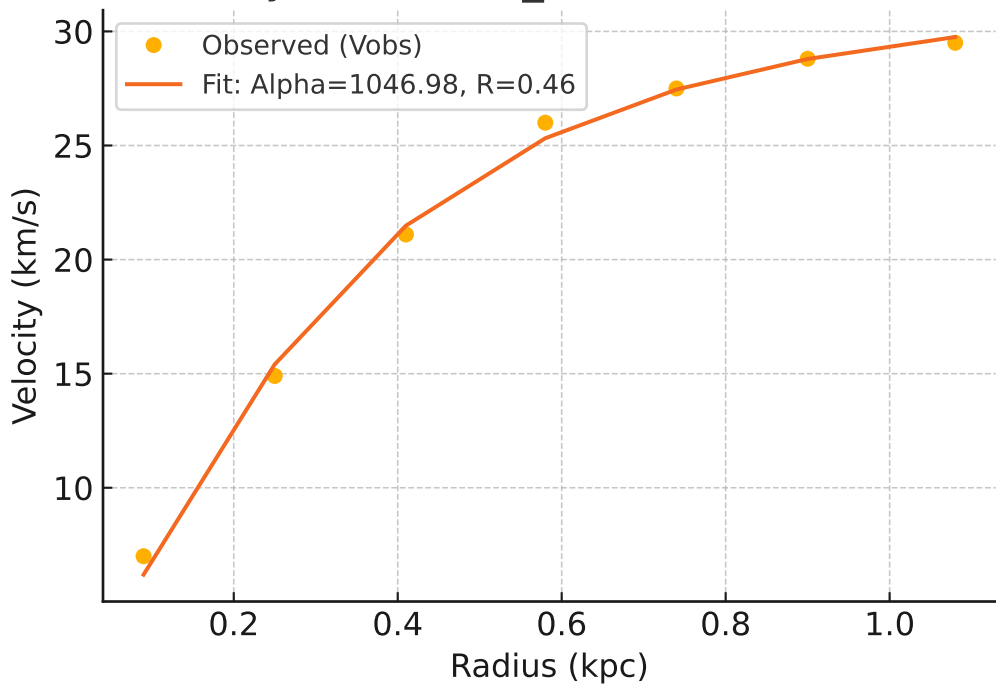
# Galaxy: UGC12632\_rotmod ( $R^2=0.985$ )



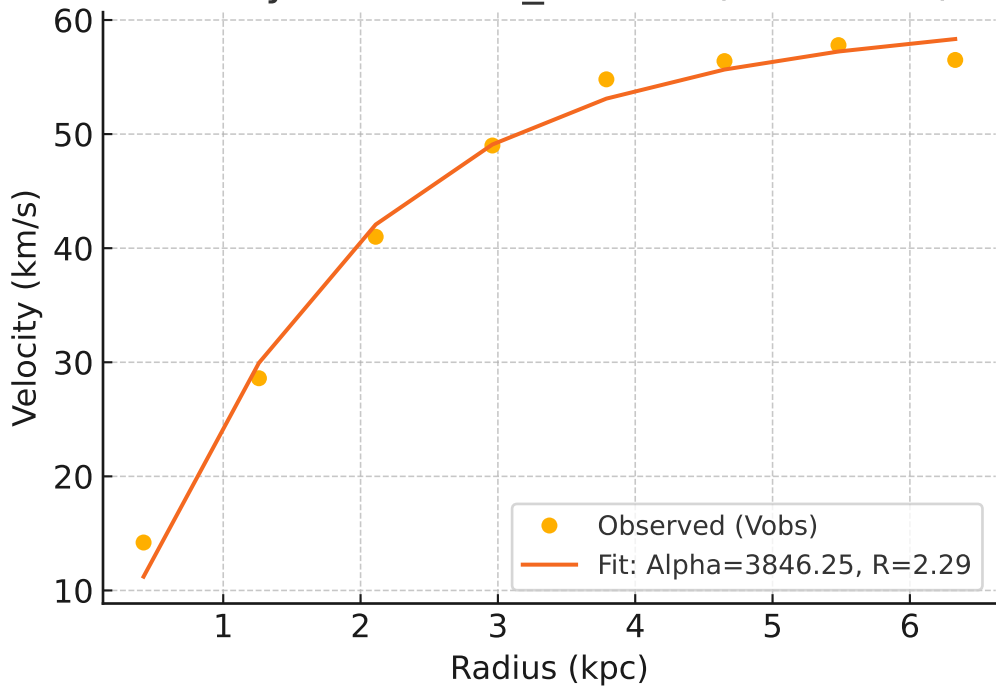
# Galaxy: UGC12732\_rotmod ( $R^2=0.912$ )



# Galaxy: UGCA281\_rotmod ( $R^2=0.996$ )



# Galaxy: UGCA442\_rotmod ( $R^2=0.989$ )





# Galaxy: UGCA444\_rotmod ( $R^2=0.977$ )

